THE INTELLECTUAL OBSERVER.

MAY, 1867.

THE NEW OAK-FEEDING SILKWORM OF CHINA.

BY JOHN R. JACKSON,

Curator of the Museum, Royal Gardens, Kew.

(*With a Coloured Plate.*)

In years gone by, when the present generation of men were boys at school, almost the first lesson learnt in Natural History was the rearing and cultivation of silkworms. If our self-imposed lessons in sericulture were calculated to implant a taste in this direction for development on a larger scale in after life, what a nation of silk cultivators we should by this time have been. We, as boys, used to look upon the little creatures so busy enclosing themselves in their silken houses, and think it almost past belief that our mothers' and sisters' dresses could be composed of so many of those silky cocoons. Since the days of which we speak a great revolution has taken place in the culture of silkworms, and boys in these days could scarcely be expected to keep themselves posted up in all the newly introduced insects.

The disease which has made such ravages amongst the *Bombyx mori*, or common mulberry-feeding silkworm, in the South of Europe, has been the means of directing attention to new sources for a supply, or at least for aids to the ordinary supply of silk. This, like the cotton, the paper, and the cinchona questions, has become one of great importance. In the great silk cultivating districts in the South of Europe a failure in the supply of this article would, to those populations, be as keenly felt as the cotton famine was to our own operatives a few years since, besides seriously affecting one of our home industrial classes, the silk weavers. Science has also gained something, and will probably gain more, from the experiments in the acclimatization of these insects, as in the case of the *Bombyx Cynthia*, or ailanthus worm, which is proved not only to exist, but even to be more healthy and vigorous in this country than in France. It is now about ten years since the *Bombyx Cynthia* was first reared in Europe, and since then

many others from India, China, Japan, and Australia have been brought into notice.

The latest of these is the oak-feeding insect of China, the *Antheræa Pernyi*, Guer. Menne. It produces what is known as mountain silk, which has of late become a most important article of trade amongst the Chinese. A description of this insect, and of the oaks upon which it feeds, will probably be of some interest to the readers of the INTELLECTUAL OBSERVER. Specimens of the foliage and the acorns of these plants, together with some cocoons containing chrysalids, and some hanks of the silk, were recently received at Kew from China, and from these materials the species of Quercus have been decided. Two of them, called by the Chinese respectively large and small "Tsing-kang-lew," appear to be *Quercus Mongolica*. Another called "Hoo-pŏ-lŏ," is *Quercus obovata*, Bunge, the leaves of which are larger and darker in colour than those of *Quercus Mongolica*. There is also a marked difference in the acorns, which are larger, and the scales long and tapering, and of a dark brown colour, thus giving to the cup the appearance of being covered with long brown fur, which also partly covers the acorn itself. The fourth is called "Tseen-tso-tsze," and is the *Quercus serrata* of Thunberg. The silkworms fed upon this oak produce the best silk; the tree, however, is not so common in the silk districts as either of the other species.

The next best quality of silk is produced by feeding the insects upon the leaves of *Quercus Mongolica*, those of *Quercus obovata* producing the most inferior description. Two crops of silk are produced by the *Antheræa Pernyi* in one year—a spring and an autumn crop. The cocoons, which are very large, as will be seen by the Plate, are carefully selected by the silk growers after the autumn crop of silk has been collected, and stored away in baskets, which are usually hung up in ordinary living rooms for the spring. The ordinary heat of a Chinese living room during the winter seems to be quite sufficient to prevent the frost affecting the chrysalids. The temperature of a Chinese dwelling in the mountain silk districts is during the greater part of the winter considerably below freezing point. It is thought that the chrysalis would not be affected even if exposed on the trees during an ordinary winter night in the Chinese forests, and if this be so, it will probably prove hardy enough to bear our climate. Towards the end of April the oaks upon which the caterpillars feed begin to open their young leaves, and to push forward the growth of these leaves so as to have food in readiness for the caterpillars when hatched; twigs are cut off the trees, and placed either in tubs of water in dwelling-houses, or in pools and mountain streams. By the time the leaves have expanded, the moths have made their

escape from the cocoons, have paired, deposited their eggs, which are hatched on sheets of paper upon which the young leaves of the oak are placed. The insects are thus nursed and nourished for a few days, by which time they have grown to about an inch in length. They are then transferred to the trees themselves on the hill slopes, the younger and the most tender-leaved plants being selected. Some days elapse before the caterpillar moults for the first time; it also changes its colour from black to green, and increases considerably in size. It goes through four of these changes, after each of which its bulk is increased, but it retains its green colour. It now begins spinning its silk, and of course encloses itself in its cocoon, there again to take the chrysalis form. These natural changes are gone through much quicker in the spring than in the autumn season, a difference of five or six weeks existing. In each season, as fast as the caterpillars consume the leaves of one oak bush they are removed by the attendant silk cultivator to another, the youngest bushes being first used.

Mr. Meadows, the English Consul at Newchang, says, "I was in some of the silk valleys from the 29th of August to the 12th of September, and had an opportunity of observing the autumnal worms in their last stages. The most advanced began weaving their cocoons around them on the 2nd of September, but at this time a large proportion of the worms were still in the stage between the third and fourth sleeps, while others, which had cast their skins for the last time, were feeding hard in preparation of the work of cocoon spinning. On the 12th of September fully one half were enclosed in, or busy with, their cocoons, while the most backward had all changed their skins for the fourth time."

As the description of the insect, as given by Mr. Meadows, may be better understood by many of our readers than a purely technical one, we will quote it entire:—"Just before spinning its cocoon, it is a bright green-bodied grub or caterpillar of about 3½ to 4 inches in length, with a light brown head. On its pale brown face there are six or eight small black specks. Its body has twelve joints. On eight of these, it has on each a pair of claws, five pairs of what I shall call back claws on the hinder part of the body, and three pairs of front claws on the forward part. The hindermost, or tail joint, has a pair of the back claws; then there are two joints without claws; then come four joints, each with a pair of the back claws (one on each side); then come two joints without claws; and then the three foremost joints, each with a pair of the front claws. The five pairs of back claws are less developed as claws than the front ones, being, to outward appearance, of the same soft green matter that the body is composed of; and merely tipped

many others from India, China, Japan, and Australia have been brought into notice.

The latest of these is the oak-feeding insect of China, the *Antheræa Pernyi*, Guer. Menne. It produces what is known as mountain silk, which has of late become a most important article of trade amongst the Chinese. A description of this insect, and of the oaks upon which it feeds, will probably be of some interest to the readers of the INTELLECTUAL OBSERVER. Specimens of the foliage and the acorns of these plants, together with some cocoons containing chrysalids, and some hanks of the silk, were recently received at Kew from China, and from these materials the species of Quercus have been decided. Two of them, called by the Chinese respectively large and small "Tsing-kang-lew," appear to be *Quercus Mongolica*. Another called "Hoo-pŏ-lŏ," is *Quercus obovata*, Bunge, the leaves of which are larger and darker in colour than those of *Quercus Mongolica*. There is also a marked difference in the acorns, which are larger, and the scales long and tapering, and of a dark brown colour, thus giving to the cup the appearance of being covered with long brown fur, which also partly covers the acorn itself. The fourth is called "Tseen-tso-tsze," and is the *Quercus serrata* of Thunberg. The silkworms fed upon this oak produce the best silk; the tree, however, is not so common in the silk districts as either of the other species.

The next best quality of silk is produced by feeding the insects upon the leaves of *Quercus Mongolica*, those of *Quercus obovata* producing the most inferior description. Two crops of silk are produced by the *Antheræa Pernyi* in one year—a spring and an autumn crop. The cocoons, which are very large, as will be seen by the Plate, are carefully selected by the silk growers after the autumn crop of silk has been collected, and stored away in baskets, which are usually hung up in ordinary living rooms for the spring. The ordinary heat of a Chinese living room during the winter seems to be quite sufficient to prevent the frost affecting the chrysalids. The temperature of a Chinese dwelling in the mountain silk districts is during the greater part of the winter considerably below freezing point. It is thought that the chrysalis would not be affected even if exposed on the trees during an ordinary winter night in the Chinese forests, and if this be so, it will probably prove hardy enough to bear our climate. Towards the end of April the oaks upon which the caterpillars feed begin to open their young leaves, and to push forward the growth of these leaves so as to have food in readiness for the caterpillars when hatched; twigs are cut off the trees, and placed either in tubs of water in dwelling-houses, or in pools and mountain streams. By the time the leaves have expanded, the moths have made their

escape from the cocoons, have paired, deposited their eggs, which are hatched on sheets of paper upon which the young leaves of the oak are placed. The insects are thus nursed and nourished for a few days, by which time they have grown to about an inch in length. They are then transferred to the trees themselves on the hill slopes, the younger and the most tender-leaved plants being selected. Some days elapse before the caterpillar moults for the first time; it also changes its colour from black to green, and increases considerably in size. It goes through four of these changes, after each of which its bulk is increased, but it retains its green colour. It now begins spinning its silk, and of course encloses itself in its cocoon, there again to take the chrysalis form. These natural changes are gone through much quicker in the spring than in the autumn season, a difference of five or six weeks existing. In each season, as fast as the caterpillars consume the leaves of one oak bush they are removed by the attendant silk cultivator to another, the youngest bushes being first used.

Mr. Meadows, the English Consul at Newchang, says, "I was in some of the silk valleys from the 29th of August to the 12th of September, and had an opportunity of observing the autumnal worms in their last stages. The most advanced began weaving their cocoons around them on the 2nd of September, but at this time a large proportion of the worms were still in the stage between the third and fourth sleeps, while others, which had cast their skins for the last time, were feeding hard in preparation of the work of cocoon spinning. On the 12th of September fully one half were enclosed in, or busy with, their cocoons, while the most backward had all changed their skins for the fourth time."

As the description of the insect, as given by Mr. Meadows, may be better understood by many of our readers than a purely technical one, we will quote it entire:—"Just before spinning its cocoon, it is a bright green-bodied grub or caterpillar of about 3½ to 4 inches in length, with a light brown head. On its pale brown face there are six or eight small black specks. Its body has twelve joints. On eight of these, it has on each a pair of claws, five pairs of what I shall call back claws on the hinder part of the body, and three pairs of front claws on the forward part. The hindermost, or tail joint, has a pair of the back claws; then there are two joints without claws; then come four joints, each with a pair of the back claws (one on each side); then come two joints without claws; and then the three foremost joints, each with a pair of the front claws. The five pairs of back claws are less developed as claws than the front ones, being, to outward appearance, of the same soft green matter that the body is composed of; and merely tipped

with a small piece of hard substance of the same light brown colour as the head. The three pairs of front claws are, on the other hand, curved; and are entirely composed of the hard, light brown substance. The five pairs of back claws serve as feet, by means of which the animal holds on to the twig or stem part of the leaf, while the front claws serve as hands, by means of which it twists round the edge of the leaf to its mouth. When the grub is in one of its torpid periods, it holds on to the twig solely by means of the five pairs of back claws, the foremost five joints (three with claws and two without) being altogether detached from the twig, in the air. A little above the claws on each side there is, on each joint or segment, a bright blue speck, out of which two or three hairs grow. A little above these blue specks there is on each side, down the last or tailmost, nine joints, a brownish streak, which two streaks widen and join together as a brown band on the tail joint. On the eighth and ninth of the joints, counting from the tail end, there are on this brown streak two silvery or white metallic coloured spots on each side. The brown band does not extend to the foremost three joints; on the other hand, each of these joints has two blue specks on each side, one above or higher up than the other. The animal is thickest about the second and third joints, counting from the head, and tapers off somewhat towards the tail."

"When the worm begins to make its cocoon, it selects two or more oak-leaves, more or less facing each other, and lower than the twig from which they proceed. These leaves it joins together by a network of its silk thread, which thread keeps issuing from its mouth as it moves its head from one leaf to the other. It holds on, in the meantime, by its back claws to the twig. When the leaves are sufficiently joined to form a sort of cup or basket under the twig to which it is holding, it loosens its hold, and drops into the receptacle it has thus formed. The hindermost seven joints of the body are then with the tail joints slightly curled in, drawn together, and, remaining in a state of total inaction, serve, I presume, merely as a store from which the silk thread matter is drawn. The work of further self-inclosure the animal does with his head, and the foremost five joints of the body. It first quite surrounds itself with the loose flossy-like silk which forms the outer portion of the cocoons as they come to market, and through which its green body remains for a time visible. It then gradually forms the dense, hardish, skin-like substance which constitutes the inner portion of the cocoon.

On opening a cocoon which had been recently formed, and was to outward appearance quite finished, I found inside a complete green worm curled up in the way I have described as

to its hind part, and with the fore part in the condition in which it is when the animal is in one of its sleeps on the bush. After a while the fore part began to move, and the animal to spin silk, which it attached at each turn of its head to the surface of a table on which I had placed it. It seemed to be labouring to increase the thickness of its cocoon, being, doubtless, roused to the necessity of so doing by the feel of the open air to which it was again exposed. I judged that if the cocoon had not been opened, the animal would, after a sleep in it, have proceeded to thicken the inner surface by further thread spinning, and have gone on so doing till its bulk was sufficiently decreased for its turning into the chrysalis shape."

From the foregoing description of the *Antheræa Pernyi*, it will be seen how close it agrees in habit with the *Bombyx Cynthia*, or ailanthus feeder. It remains yet to be proved whether the insect can be successfully reared in this country, and whether it will feed on the leaves of any of our British oaks. If so, and it succeeds in our climate as well as the ailanthus worm, it will prove a valuable companion to that useful insect. The silk appears very strong, and when properly cleaned will, no doubt, prove tolerably bright and flossy. As an article of export from China, it will probably prove a valuable addition to our trade with that country, and if acclimatized with us, would of course be valuable to our home productions.

It appears that these insects are not only useful as silk producers in their native country, but the insides of their huge bodies are drawn out by the Chinese, who make fishing-lines of them, which are of a somewhat similar nature to catgut. We are told by a celebrated traveller in China that these can be sometimes drawn out to a continuous length of fifteen or twenty yards.

The drawing, by Mr. Fitch, is made from a moth which escaped from a cocoon about the middle of February last. This cocoon was kept, amongst others in the possession of the writer, in an ordinary sitting-room, and up to the present time none of the others have made their appearance.

The Plate represents—1. The Cocoon, nat. size; 2. Chrysalis, nat. size; 3. Moth, nat. size. The leaves and acorn are those of *Quercus serrata*, Thb., which produce the best kind of silk.

AN EIGHT DAYS' RAMBLE IN CAPE COLONY.

BY GEORGE E. BULGER,

Captain 10th Regiment.

"Suppose we ask for a week's leave, and take a trip to the Paarl?" said Hendrick to me one morning at the end of July, as we sat at breakfast together in the mess-room at Cape Town. "There ought to be some fine mountains in that direction, and we might also get some shooting." "By Jove, it is a good idea," I answered; "a few days of wandering about would be very pleasant, besides the opportunity of seeing a part of the country new to us."

The leave of absence was easily obtained, and at eleven o'clock the next morning we were travelling towards our destination by the Cape Town and Wellington Railway. We were the sole occupants of the carriage, and, indeed, almost the only passengers in the train; for the traffic on this line is very small, and we heard that it does little more than pay expenses.

For more than four years we had not seen a railway carriage; and the sensation of being once more whirled along by the iron horse was to me quite delightful, after the various uncomfortable modes of travelling with which I had become familiar on the comparatively uncivilized frontier, where it had been our destiny to be quartered since March, 1860.

The morning was very fine, and although it was rather early in the season for us to see the full beauty of the country, yet even the monotonous-looking Cape Flats, between Cape Town and Stellenbosche, a distance of thirty-one miles, were to a certain extent attractive, from the bright flowers which were everywhere coming into bloom amongst the thin and scattered bushes that studded the wide, arid-looking expanse of glittering white sand. Near Stellenbosche the mountains commence, and thence to the Paarl they form the main features of the scenery. Those close to the former place—the Klapmuts range, I believe—are exceedingly bold and grand; they are apparently of great height and utterly barren; indeed, seemingly naked rocks, of imposing form and majesty. Next them comes a more lengthy tier, which, I understand, are the Drakenstein or Dragon's Stone Hills. They, too, are treeless masses of solemn-looking rock, trending away to the northward, and walling-in the valley of the Great Berg River on the eastern side.

The Paarl is eighteen miles from Stellenbosche, and we arrived there shortly after one o'clock. The railway station is

fully two miles from the town, but we found carts in waiting for new-comers, one of which soon carried us and our belongings to the exceedingly pleasant little hotel kept by Mr. Schmidt, a stout, jolly-looking Dutchman, whose kindness and attention to our wants during the few days we spent under his hospitable roof will long be remembered by Hendrick and myself. The drive from the station to the hotel was very pleasant; the country was fresh and bright looking; and the noble pine-trees and oaks, which lined some portions of the road, elicited our warm admiration.

We spent the remainder of the day in rambling about the Paarl—which, being translated into English, means Pearl—and examining the general features of the valley. The village, or town, is one long street, which stretches in a direction parallel to the course of the Great Berg River for several miles; the people told us eight, but I should say it is a good deal under that distance. The houses are all built in the Dutch style, and, almost without an exception, are shaded with pine-trees, which add vastly to the beauty and picturesque appearance of the place. The trees, moreover, are by no means entirely of an indigenous character, for those of many dissimilar countries and climates are found here growing happily together, and thriving in the genial atmosphere of this lovely valley. Lofty pines, whose deep green foliage is suggestive of more northern regions, contrast gracefully with the delicate acacia-like branches of the Pride of India; majestic oaks of high antiquity stand side by side with the Blue Gums of South Australia, and the scarlet-flowering pomegranates, said to have been first brought from Carthage; here are mulberry-trees of immense size; there the soft English-looking woody poplar, loquats, almonds, peach-trees, opuntias, huge stately agaves, luxuriant orange-trees, laden with golden fruit and redolent of rich perfume; camellias, with their peerless blossoms; scarlet aloes; and whole hedges of roses;—all blend harmoniously into one lovely and smiling picture. Vineyards are attached to almost every house, for the Paarl is in the heart of one of the finest wine districts of the country; but at the time of our visit the plants were all brown and leafless, so that they added little to the beauty of the scene around them.

The Great Berg River, a considerable stream, flows through the valley a little below the town, and eventually after a winding course of about a hundred miles from its source in the Fransche Hock Mountains, falls into the South Atlantic Ocean at St. Helena Bay, on the west coast. In the neighbourhood of the Paarl it is tame and uninteresting, for its banks are treeless and monotonous-looking, contrasting forcibly with the fine, bold scenery of the mountain-ranges on either hand, and the

softer beauty of the town itself. We could scarcely form an estimate of the width of the valley, which may perhaps be two or three miles across; but it appeared to be a flat, sandy plain throughout, ornamented only by a low, shrubby vegetation, which seemed in many places very sparse and thin. On the opposite side to the Paarl Mountain runs the lofty chain of the Drakenstein, displaying much grandeur of outline and variety of configuration, but everywhere treeless, naked, and barren; apparently a series of precipitous crags and peaks of glittering sandstone, with here and there a tall, snow-capped summit standing out in bold relief from the deep azure of the distant sky. To the right and left huge mountains still meet the view, and the valley is almost entirely encompassed by these towering boundaries of rock.

* * * * * * *

Next morning, just as I had finished dressing, Hendrick put his head into my room, and began to reproach me for spending the "best part of the day in bed," the hour being then only seven o'clock. Every man, they say, is mad on some point, and Hendrick's peculiar lunacy is a fondness for getting up in the middle of the night, and walking for several miles before any other Christian or infidel has roused himself from his nocturnal slumbers. Just such a feat had he been performing on the occasion alluded to, and it was not to be wondered at that his appetite was alarming in the extreme. However, Johannes, the attendant-spirit of the hotel, was very prompt in his measures on that morning, and ere long we sat down to a sumptuous breakfast. As soon as Hendrick could afford time from the eating and drinking for conversation, he informed me that he had been half way up the mountain at six o'clock, and he wound up with a proposition that we should devote the rest of the day to more extended explorations in the same direction.

The Paarl Mountain is one of the celebrities of the place, and so I was fain to agree to my companion's proposal, albeit I felt uncommonly lazy, and the day promised to be exceedingly hot; a promise that was amply redeemed before the sun had reached the zenith. However, after breakfast we started, and soon had commenced the ascent, for the foot of the hill was scarcely five hundred yards distant from the hotel. The path upwards was well marked, clear of grass and bushes, but steep, and almost slippery, the red earth having been worn quite smooth by being constantly walked over, and baked hard by the hot sun. As may be supposed, we paused frequently, for in such weather the climb was rather hot and fatiguing; and during these halts we had ample opportunity for studying the beautiful landscape afforded by the lovely Paarl, nestling in

the valley at our feet, with its glorious background of high and rugged mountains.

In due course of time we reached, not exactly the summit, but one of the shoulders of the mountain; for the former, a somewhat semicircular mass of smooth granite, is not easy of access from the side on which we approached it; and there, again, we paused to look around us. On our right a small rivulet was winding downwards through a rocky ravine, fern-clothed and shaded by dense clusters of small shrubs, amongst which the elegant and graceful sugar-bush (*Protea nana?*) was most abundant; its large rose-coloured blossoms affording immense attraction to many sun-birds, whose weak but pleasing notes we heard everywhere about us. There were three species in tolerable plenty—the dark green one (*Cinnyris famosa*), one with a green head, orange breast, and grayish body (*Cinnyris violacea*), and a third, much larger than the other two, and more plainly dressed, with a long tail (*Melliphaga Caffer*).* The scarlet flowers of the wild sacha (*Leonotis leonurus*) peeped out every here and there from the clumps of rank vegetation, which almost shrouded portions of the little brook from the daylight; and other blossoms, equally beautiful though of less striking colours, were very numerous. There were not many birds visible, excepting those I have already mentioned; a few sparrows (*Passer arcuata*); a flock or two of those lovely little long-tailed whidah-finches, the *Vidua erythrorhyncha* of Swainson, which is known in some parts of the colony by the extraordinary appellation of "king of the Jews"; and, near the summit of the ridge, a pair of my favourite little gray finches (*Fringillaria vittata*), called by the Dutch settlers "streep-kopje." I saw very few butterflies; only one specimen of *Acræa horta*, and two or three of the very beautiful and very common *Pyramis cardui*, displaying their usual fearlessness, and permitting me to approach quite close to them without any seeming alarm.

On our left was the summit of the mountain, a huge, naked rock towering up for fully fifty or sixty feet above us, with precipitous sides and, apparently, a rounded top. Behind us the land dipped for a short distance, and then rose again gradually, sloping upwards towards two immense semicircular masses of the same imperishable granite, considerably higher than the peak which is visible from the town. Standing within a short distance of one another, and rising far above the surrounding vegetation, these two smooth, bald-headed mountains were most striking objects, and we soon resumed our walk and strode over to them. The ascent of the one upon our left

* I am indebted to the kindness of my friend E. L. Layard, Esq., the Curator of the South African Museum, for the names of these and many other birds.

seemed feasible enough, but it was so girt with tremendous precipices, that we did not like to risk the slippery footing on the smooth, naked granite ;* the other, from the side next to us, was utterly beyond our powers of climbing. Save the hard gray lichens which covered the stone profusely, and a patch or two of some tiny moss in the crevices here and there, not a shred of vegetable life was visible beyond a certain point; and the line of demarcation between rock and verdure was very strongly apparent. Just where the latter ended we found some beautiful yellow *Oxalidæ*, and a very lovely white sundew (*Drosera trinerva*),† which was just unfolding its exquisite little flowers. Here, also, were many clumps of the common English chickweed (*Stellaria media*), an old friend amongst the strangers that grew around.

In the shallow valley between the two mountain ridges, there were numbers of huge boulders confusedly scattered over the ground, some of which were of such gigantic size as almost to constitute small mountains in themselves. An enormous slice, apparently from the summit of the peak, was resting against one of these great rocks, and the two combined to form a spacious cavern, seemingly almost rain proof, and possessing a hard, smooth flooring of dry earth: we paced this natural apartment, and found it to be about six feet in length, by about four or five in width. It was evidently a place of continued resort, for the walls were inscribed with many names. On our return we were told that this was only one of several caverns which are to be found on the curious mountains.

The gorge between the two summits was very narrow at first, but it widened rapidly as we advanced, until it opened into an undulating plain at the foot of the mountains on the other side. It was full of trees and broken rocks, and a little stream ran dancing down the descent into the plain I have mentioned. We passed through the narrowest part of the defile, and seated ourselves beside the little brook, whose crystal waters were splashing merrily down the hill-side, between patches of green and luxuriant moss begemmed with wild-flowers of rare beauty, amongst which the exquisite little sundew I have mentioned, was most abundant. It was a charming spot, and we appreciated its loveliness to the fullest extent. Behind us rose the enormous and almost naked masses of the mountains, towering upwards in all the pride and majesty of

* On a subsequent occasion I ascended this peak, and found that the danger was more imaginary than real. The rock is so rough and scored by the weather that it affords tolerably secure footing, and the noble view, obtained from the summit, amply repays one for the climb.

† I have to thank the colonial botanist, the Rev. Dr. Brown, for his kindness in naming this plant for me.

the primitive granite: at our feet, the gurgling waters of the stream were wandering away through the tangled vegetation down to the level of the plain (or rather, a succession of billowy undulations covered with some sort of grass, and ornamented, here and there, with trees and bushes of many kinds), which was spread out like a map before us, and bounded in the distance by other hills again. The picture thus presented to us must surely be, at all times, a lovely one; and how much more charming than usual when seen under the influence of such glorious weather!

During the hour that we spent at this sweet spot, a large black and white eagle was sailing about the summit of the mountain, apparently to the great annoyance of a pair of hawks, who, every now and then, attacked the royal bird most savagely, uttering harsh screams of anger as they approached him; and, although they did not succeed in driving him away from the place, he had such a wholesome dislike to a combat with them at close quarters, that, whenever they manifested hostile symptoms, he invariably retreated. He was a large specimen of *Aquila Verreauxii*, and his persecutors a pair of rock kestrils (*Tinnunculus rupicolus*). From this place we had a good view of the two large rocks, and of their rifted and furrowed sides, in some places so high and perpendicular, as to be apparently inaccessible even to the krantz-loving baboons.

After luncheon we descended to the rolling country I have alluded to, and, eventually, returned to the Paarl by a ravine that lies a little north of the peak. With the exception of the three species of sun-birds that I have before mentioned, and a covey of red-winged partridges (*Francolinus Le Vaillantii*), which we flushed amongst the protea bushes, we saw no living creature during the remainder of the walk; however, the curious masses of rock which were scattered about everywhere, and the variety of plants rendered the ramble sufficiently interesting. We saw one fine specimen of the waggon-boem, or *Protea grandiflora*, and a few of the beautiful silver trees (*Leucadendron argenteum*), which are so abundant on Table Mountain. In the ravine a small stream of water, almost hidden by the branches of the trees that grew on either side of it, dashed furiously over the rocks, amidst piles of luxuriant ferns of many kinds, on its way to the river below.

We enjoyed the most excellent dinner which Mynheer Schmidt set before us, as we deserved to do after our long ramble, and retired early to rest, resolved to start next morning for Wellington.

* * * * *

We left the Paarl by the 9.47 train and reached Welling-

ton, distant nine miles, at 10.14. Though a picturesque village with some fine mountains in its vicinity, it is not equal to the Paarl in beauty. The hills are further off; the trees are not so fine or so numerous; and the site of the place is less romantic: in short, the grouping of the scenic elements is not so striking, and it is decidedly less attractive in its general features than its older and more celebrated rival.

We stayed but a short time at this place, and then left for Darling Bridge, through the famous pass called Bain's Kloof, in honour of the engineer who planned and constructed the magnificent road across the Drakenstein Mountains.

I question if there is a wilder drive in the whole of Cape Colony than that through Bain's Kloof. It commences just beyond Wellington, winds slowly upwards for about seven miles, and then gradually descends again to Darling Bridge. I do not know the distance between the two places, but I should imagine it is at least twelve or fourteen miles. The road is scarped out of the mountain-side, and, though broad and safe, is very suggestive of danger in many parts, where the rocky incline slopes suddenly down to the deep valley of the river, which winds along in the very bottom of the enormous ravine. As both the ascent and descent are sufficiently gradual, the road is necessarily very winding in its course, and a succession of wild and magnificent, though limited, views are presented throughout. The solemn stillness of the tremendous kloof is almost as remarkable as the strikingly barren and desolate aspect of the rough mountain-sides, destitute of trees or almost any other vegetation, excepting that characteristic of the most stony wildernesses of the country. Proteas of many species, and the everlasting Rhinosterbosch (*Elytropappus rhinocerotis*) abound, and it would not be exaggeration of much magnitude to say that these plants are the sole representatives of the vegetable world in this gloomy pass. For the first part of the drive the road is planted on the outer side with young oak-trees, which promise in the future to add much to the beauty of this magnificent highway.

The valley of the river at Darling Bridge is a swamp, in which are growing quantities of the strange-looking palmiet (*Prionium palmita*), with its enormously thick, spongy stems. Pools of water abound, like those in an Irish bog, and quite as treacherous in appearance, though there did not seem to be much actual difficulty in getting through them. On either side of the narrow valley are high, grand mountains, very rugged, and very picturesque, but bleak and savage-looking.

The Darling Bridge, whence the place takes its name, was carried away some time since, and it has not yet been repaired. The hotel is the only house within sight, but its interior

showed many evidences of civilization that we were not prepared to meet with in such a wilderness; there were pictures and periodicals, and actually one of the latest numbers of the London *Times*, as well as several cabinets of insects tastefully arranged and in beautiful preservation.

We returned to Wellington the next morning, where we were detained by rain for a day and a half.

* * * * * * *

At Wellington we heard a good deal of a lake in the Tulbagh district, called Vogelsvlei, which was said to abound in wild-fowl, and after making due allowance for exaggeration on the part of our informants, we decided that it would be worth our while to pay this noted sheet of water a short visit. Accordingly, having re-chartered old Howard's cart for three days more, away we went.

After a pleasant drive of about fifteen miles over a better cultivated country than I had yet seen at the Cape, we arrived at Retief's Hotel, close to Koopman's River. This stream is a tributary of the Great Berg, and I believe it rises in the Tulbagh range of mountains. At low water it is an insignificant brook, but when full, they told us, its passage is sometimes an impossibility without a boat. The hotel is a solitary building, kept by a Cape Dutchman and his brother. It is a snug little place, and the proprietors were most civil and obliging; everything that they could possibly do for our comfort was done freely and gladly, with genuine hospitality, and their charges were moderate in the extreme.

In front of the hotel, at the distance of about a quarter of a mile, runs the Great Berg River, and considerably beyond it, the bold and picturesque mountain called Riebeck's Casteel forms a most imposing object. In the opposite direction, three or four miles behind the house, are the noble, but barren-looking hills of the Tulbagh range, the tall peak of the Winterberg * rising above them all, in the left distance, and flashing back the sunlight from its snow-covered summit. Near the foot of these mountains lies the Vogelsvlei, which, however, is invisible from the hotel, owing to the lowness of its position.

At the time of our visit the place was gay with multitudes of bright-hued flowers, principally the blossoms of many genera of the world-renowned Cape bulbs: *Oxalidæ* of several kinds; the scarlet blood-flower (*Hæmanthus coccineus*); the South African tulip (*Homeria collina*), a lovely, but most poisonous plant, resembling somewhat in shape our common daffodil; ixias and gladiolas of many species; *Babianæ*; and the magnificent trumpet-lily (*Richardia Æthiopica*).

* 6,840 feet above the sea level.—*Hall.*

When we arrived on the spot we found that the chances of sport were very far from being as great as we had been led to believe. Our host informed us that there were plenty of geese and ducks, but that they were most difficult of approach; that the lake was private property; and, finally, that there was no boat on it. Formidable as were these obstacles at first sight, they were eventually smoothed away without much difficulty. The Retiefs declared they could get leave for us to try our guns amongst the birds, and they offered to put their own punt into a waggon and take it to the vlei for our especial benefit. No sooner said than done! Hendrick and I were not long in deciding to follow out the plan suggested by our hosts, and immediately after breakfast we proceeded in a body to the farm-yard, where the punt was lying; a waggon with four horses was already inspanned, so that we had nothing to do but lift the boat into it. Our own cart was also prepared for us at the same time, and in about ten minutes we had started, Mr. Franz Retief, the younger of the two brothers, having volunteered his services as guide for the occasion. The distance between the hotel and the lake, probably about three miles, was accomplished without anything strange occurring, and on our arrival there, the old Dutchman who was said to be the owner of a portion of it, politely expressed his pleasure at being able to meet our wishes, and begged to be allowed to join the party. This was of course agreed to, and it was then arranged that four of us should go in the punt, Franz Retief to propel the vessel, and the rest of us to shoot.

The lake, or vlei, lies close to the foot of the mountains, and a good deal below the level of the surrounding country. It is totally devoid of beauty, and in point of fact, is simply an enormous shallow pond, with muddy banks and dirty-looking water. At the southern end, where we embarked, there is a stretch of marshy land, with reeds and other aquatic plants growing in it, which looked a likely place for snipe, and we promised ourselves a tramp through it after we had disposed of the wild fowl. There were numbers of ducks and geese on the vlei, the latter in small parties of about seven or eight, but we did not see any flamingoes, which we had been told were plentiful at certain times. The mud was soft and tenacious at the edges of the vlei, and the launching of the punt was a work of greater difficulty than the lifting of it into the waggon had been; however, after some resolute pushing, and a fair quantity of slipping, we got the little craft afloat, and then scrambled on board.

When we were fairly under way, we began to wonder how we were to get within range of such wary birds as geese and ducks, in an open lake without cover or disguise of any kind:

however, our guide appeared very sanguine, so we said nothing, but watched curiously his mode of pursuit. To our intense astonishment, he pulled straight for the nearest flock of geese. Two or three ducks, which were swimming about in the neighbourhood, took wing, and were soon out of sight, but the geese seemed either fascinated, or more stupid than geese ever were before, for they made no attempt to fly. They swam away from us, certainly, but otherwise showed no disposition to avoid us.

"What does it all mean?" said Hendrick to me. "Why don't they fly?" I asked of Franz Retief. "Can't fly," answered he, "they have lost the long feathers of their wings." O, ye gods! what an announcement! what a downfall to all our hopes of sport! Hendrick looked disgusted, and laid aside his gun; but, in another moment, Retief cried "Look out!" and, as he spun the punt half round until she was broadside on the troop of geese, the temptation was too strong, even for Hendrick. The birds, on the calm surface of the waters, seemed larger than they really were, and we forgot all about their wings and their supposed helplessness. Bang! bang! went both our guns—unluckily, at the same bird,—which turned up, and died satisfactorily. The remainder did not give us a chance, for, in an instant, they were gone! not into the air, but into the water; where they stayed so long that we began to suspect they were amphibious. When they reappeared, they were scattered all around us, well out of range. Having secured the dead bird, Retief put the punt about, and went after the nearest of the broken flock. But the knowing creature had learnt a lesson, and as soon as we approached him, down he went amongst the fishes, and taking a swim underneath the surface, he reappeared still further off. Retief caught sight of his head the moment it came up, and, bending to the oars, sent the punt dashing through the water in pursuit. After a long chase we shot him, and, when we had added seven more to our list, we had almost come to the conclusion that, for these geese, wings were unnecessary appendages, considering how uncommonly well they managed to baffle our attempts to shoot them.

Notwithstanding their activity, and the difficulty of getting near them, however, there was really no sport in slaying them under the circumstances; so, when we had bagged a sufficient number to supply a few of our friends with roast-goose for dinner, we landed and commenced the much more congenial occupation of walking up the snipe. Promising as the place looked, however, the result proved that it was almost uninhabited by the long-bills. I had tramped about for fully three-quarters of an hour, floundering through the shallow

water and greasy mud, before the familiar *skeap! skeap!* struck on my ear, and I caught sight of one of my pretty friends, having flirted up behind me, skimmering along towards the mountains. It was a cross shot and an easy one, so I had the satisfaction of pocketing his snipeship before many seconds had elapsed. Hendrick, who was some distance to my right, soon turned up another bird, and, after two hours, we returned to our cart with six couple, having, I believe, found all the birds in the place and killed the lot. The Cape snipe is, I imagine, *Gallinago nigripennis*,* and the species of goose that fell to our guns this day was the *Chenalopex Ægyptiacus*, or mountain goose :† the unfortunate birds were moulting, and were destitute of their primary quills at the time of our visit.

* * * * * * *

We had a most delightful drive back to Wellington. The sky was cloudless, the air cool and grateful, and the whole country magnificently green and fresh after the heavy rain of the previous days. Flowers, too, of the brightest colours bespangled the ground in myriads. Some of the fields were literally vast sheets of pink and yellow from the multitudes of oxalis blossoms, and, every here and there, the scarlet corollas of the blood-flowers (*Hæmanthus coccineus*) or of *Watsonia angusta* peeped from the green herbage on the road sides. Gazanias of a lustrous orange were wonderfully abundant, the handsome spikes of *Satyrium erectum* were just bursting into bloom, and several species of protea, with their large and elegant flower heads, almost covered the waste ground. At one part of the drive, the air was laden with a most delicious scent like that of *Coumarouna odorata* or Tonka Bean. At first we could not imagine where it came from, or what was the cause of it, but a few minutes' search showed us a small vlei perfectly white with the odorous flowers of *Aponogeton distachyon:* it was situated in the centre of a little verdant glade, round the edges of which were luxuriant copses of wild olive (*Olea verrucosa*) and other trees, grouped in the most graceful manner. Such a charming spot it was! Hendrick and I agreed that we had seen nothing more lovely during our tour.

* Vide *Ibis*, vi. 355.

† Dr. Kirk (*Ibis*, vi. 336) says "this is the worst of all the Duck kind for the table, being in many cases quite uneatable," but those which we shot at Vogelsvlei were excellent.

ANCIENT SUPPLY OF WATER TO TOWNS.

BY THE REV. W. HOUGHTON, F.L.S.

"Ἄριστον μὲν ὕδωρ," says Pindar, in his first Olympian hymn, and, if the poet's words be restricted to wholesome water, no exception can be taken to them; but if unwholesome water be the subject of remark, then the expression κάκιστον μὲν ὕδωρ is most true. The ancient Romans, though they knew nothing of the composition of water, and in matters of science were for the most part mere babes when compared with the scientific men of our day, yet unquestionably surpassed us in the matter of a supply of water to their cities. The enormous quantities of water conveyed, often from great distances, to ancient Rome by the magnificent system of aqueducts, the costliness and efficacy of the works themselves, fill us with astonishment, and ought, at the same time, to fill us with shame for allowing ourselves, in this boasted age of social progress, to come so lamentably far behind the ancient Romans in a matter whose importance it is not possible to exaggerate. The ancients justly prided themselves on their water supplies. Pliny is enthusiastic in his admiration of the system of aqueducts that supplied Rome: "If we take into consideration," he says, "the quantities of water brought into the city for the use of the public, for baths, for fishponds, for private houses, for canals, for gardens, for places in the suburbs, and for country residences, and then reflect on the arches that have been constructed and the distances traversed, the mountains that have been pierced with tunnels, and the valleys that have been levelled, we must admit that there is nothing more worthy of admiration in the whole world." Were the Roman naturalist suddenly to appear amongst us now, we can conceive what expressions of unbounded delight and surprise would proceed from his lips as he gazed on our mighty steamboats, our railroads, gasworks, the Atlantic telegraph, enabling men of two different worlds, thousands of miles apart, to speak almost as if face to face. But the system which provides the Metropolis and some other towns with water would most assuredly stand out in strong contrast to the other wonders of this age, and sink into insignificance when compared with the aqueductal system of Rome in the time of the Emperors.

The earliest notice of channels for the conveyance of water occurs in the sacred writings. Thus we read of "the conduit of the upper pool in the highway of the fuller's field" (2 Kings xviii. 17), of "the upper watercourse of Gihon" (2 Chron. xxxii. 30). The Hebrew word translated "conduit" is תְּעָלָה

(teâlâh), which Fürst derives from an unused root signifying to "bend inward," "to sink," hence, "to be hollow," or "deep." The Septuagint has ὑδραγωγός, a word of similar meaning as the Latin aquæductus. It is probable that the aqueduct for conveying water to Jerusalem from the pools near Bethlehem which Solomon made, portions of which still exist, was constructed by the orders of that king. According to Pococke, "The aqueduct is built on a foundation of stone; the water runs in round earthen pipes, about ten inches in diameter, which are cased with two stones, hewn out so as to fit them, and they are covered over with rough stones well cemented together, and the whole is so sunk into the ground on the side of the hills that in many places nothing is to be seen of it." Jerusalem appears to have been always well supplied with water, either by natural springs or by artificial modes of conveyance from "pools" into reservoirs excavated out of the rock. "Like Mecca," Mr. James Fergusson writes, "Jerusalem seems to have been in all ages remarkable for some secret source of water, from which it was copiously supplied during even the worst periods of siege and famine, and which never appears to have failed during any period of its history."* Tacitus in a few words describes both the natural and artificial supplies of water in Jerusalem: "Fons perennis aquæ, cavati sub terra montes, et piscinæ cisternæque servandis imhibus." A perennial spring of water, subterraneous caverns scooped out of the mountains, pools and tanks for collecting rain-water (*Hist.*, v. 12). The ancient Greeks, according to Strabo (*Geog.*, iii. 5, 7, 8), held in very little esteem (ὠλιγώρησαν) such works as paving roads, constructing sewers and aqueducts. There were certainly numerous springs and fountains in ancient Greece, and the inhabitants were for the most part content to draw from these, though we can hardly suppose that they found these natural supplies sufficient. So essential were fountains considered, that Pausanias questions the propriety of "calling that a city in which there is no supply of water" (*οὐχ ὕδωρ κατερχόμενον ἐς κρήνην*). The same writer speaks of a fountain at Megara, built by Theagenes, "which was well worthy of inspection, both on account of its size, ornamentation, and the number of its pillars." Corinth, certainly, was well supplied with water; numerous baths were made, some at the public expense, others at that of the Emperor Adrian; a "magnificent one, adorned with various kinds of stone, stood near the temple of Neptune." To pass over several other allusions to fountains, we may notice the *ennea krounos* (nine pipes) at Athens. Athens appears to have been badly supplied with good drink-

* Smith's *Dictionary of Bible*, i., p. 1028.

ing water, and was far inferior to Rome, both in its houses, streets, sewers, etc. Dicæarchus, who visited Athens (*circ.* B.C. 400), speaks of it as being "dusty, badly supplied with water, badly laid out on account of its antiquity, most of the houses mean, and only a few good." There were many wells in the city, but the water, being of a saline nature, was not good for drinking, though of course much used for domestic purposes. The *ennea krounos* was originally called *callirhoë*, when the springs were open (*Thucyd.* iii. 15), but the Peisistratidæ converted this natural spring into an artificial supply, by laying down conduits or pipes, so that *ennea krounos* was the architectural term, *callirhoë* that which denoted the natural spring. "The spring flows from the foot of a broad ridge of rocks which crosses the bed of the Ilissus, and over which the river forms a waterfall when it is full, but there is generally no water in this part of the bed of the Ilissus, and it is certain that the fountain was a separate vein of water, and was not supplied from the Ilissus. The waters of the fountain were made to pass through small pipes pierced in the face of the rock, through which they descended into the pool below. Of these orifices seven are still visible. . . . The pool which receives the waters of the fountain would be more copious but for a canal which commences near it, and is carried below the bed of the Ilissus to Vunó, a small village a mile from the city, on the road to Peiræeus, where the water is received into a cistern, and supplies a fountain on the high road and waters gardens. The canal exactly resembles those which were in use among the Greeks before the introduction of Roman aqueducts, being a channel about three feet square cut in the solid rock."* It certainly does seem somewhat remarkable that the ancient Greeks should have been so completely surpassed by the Romans in this respect, for it is clear that the Greeks were not deficient in engineering skill, as is witnessed by the two artificial tunnels or *emissarii* (portions of which are still to be seen), which in very early times were pierced through the rock in order to carry off the water from the lake Copais in Bœotia. The deepest of these tunnels is thought to have been from 100 to 150 feet, and nearly four miles long.

The early inhabitants of Rome got their water from the Tiber and wells sunk in the city; but as the population increased, and as, perhaps, they found the supply from these sources unwholesome for drinking purposes, they had recourse to that magnificent system of artificial supply by means of

* See Leake's *Topography of Athens*, and Appendix xiii., "On the Supply of Water at Athens." Smith's *Dictionary of Greek and Roman Geography*, Art. Athenæ.

aqueducts which has never since been equalled by any people.

From Frontinus, who, in the time of Nero, was nominated to the honourable post of *Curator aquarum* (A.D. 97), we have a most ample account of ancient Roman water supply. According to this writer, the date of the first aqueduct is assigned to the year A.U.C. 441, or B.C. 313; others gradually were constructed, partly at the public cost, partly by the munificence of private persons, till, in the time of Frontinus, they numbered nine, and were afterwards increased to fourteen in the time of Procopius (*circ.* A.D. 360). The most remarkable of these aqueducts were the Aqua Appia, the old and new Anio, the Aqua Marcia, and the Aqua Claudia. The sources of the Aqua Appia (so called because commenced by the censor Appius Claudius Cæcus) were near the Prænestine road, about eight miles from Rome. The aqueduct, after making a circuit of about 780 paces to the left, was carried under the ground for about eleven miles, till it entered the city at the Porta Capena, from which place to the Porta Trigemena, about sixty paces, it was on arches; it delivered its water into the Campus Martius.

The old and new Anio aqueducts took their names from the river of that name; the water of the former was taken from the river about thirty miles from Rome, not far above Tibur. It should be borne in mind that the Romans, with a view to check the too rapid flow of water in straight channels, used to take them by circuitous routes; so that the length of aqueduct was generally considerably more than the distance of the source from the city. The old Anio aqueduct was very winding, and its whole length about forty-three miles, scarcely a quarter of a mile of which was above ground. Remains of this aqueduct are still to be seen near the *Porta Maggiore*, near Tivoli. The new Anio aqueduct was commenced by Caligula (A.D. 36), and finished by Claudius (A.D. 50). It began at the forty-second milestone, and was about fifty miles long; for the greater part of its length the Aqua Anio was subterranean. Some of its arches were more 100 feet high.

The Aqua Claudia was also finished by Claudius; it derived its water from two springs of most excellent water, called Cærulus and Curtius, about thirty-eight miles from Rome. For the space of thirty-six miles it formed a subterranean stream; for nearly eleven miles it ran along the surface of the ground, and it was supported on arches for the space of about seven miles. Near Rome these two aqueducts were united, forming two separate channels on the same arcades, the Anio Novus above and the Claudia below. The Aqua Claudia still forms one of the chief supplies of water to the

modern city; from the excellent quality of which it has received the name of *Aqua felice*.

The Aqua Marcia supplied the best water of all the Roman aqueducts; that brought by the old Anio from near Tibur was not fit for drinking, and it was in consequence of this, and its bad repair, that the senate commissioned Q. Marcius Rex, the prætor (B.C. 144), to build another aqueduct, which was afterwards called after him. The Aqua Marcia commenced thirty-six miles from Rome; the greater part of it was under ground; the arcades were seventy feet high, and it supplied the Capitoline Hill with water. When we consider the great number of aqueducts which poured their waters into Rome, some for drinking purposes, others for baths, *naumachia*, etc., etc., we can realize the words of Strabo, that whole rivers flowed through the streets of Rome. Supposing all the aqueducts to have been in operation at the same time, it has been roughly calculated that they would have supplied fifty million cubic feet of water daily. Taking the population of Rome to have been one million, each inhabitant might have had fifty feet every day.

The aqueducts were built with very strong masonry; the channels were made of brick or stone, and lined with a coating of cement. They were arched over, in order to keep the water pure and safe, and to exclude the sun and rain. The covering was generally an arched coping; holes were made at regular intervals in the coping to provide a vent for the air, which would otherwise have burst the roof or walls of the channel by its compression. Reservoirs were generally constructed at different points on the aqueduct in order to catch any deposit or sediment contained in the water. A vast reservoir, called *castellum*, received the water when it reached the city, from whence it flowed into other *castella*, whence it was distributed for use by the inhabitants.

But not alone in Rome did a magnificent aqueductal system obtain; it was extended through all the large cities of the vast empire. At Antioch, at Pyrgos, near Constantinople, at Metz, at Nismes, at Segovia in Spain, may still be seen relics of Roman grandeur. "The aqueducts of Rome," says Montfaucon, "were, without doubt, wonderful, on account of their great length—arcades continued over the space of forty or fifty miles; their great number, with which the Campagna of Rome was filled on every side, all this surprises us. But it must be confessed that if, without considering the total extent, we only look at any of the parts which remain round Rome, there is nothing that approached the aqueducts of Metz, of Nismes (Pont du Gard), or of Segovia." The aqueduct of Metz extended across the Moselle, and conveyed water

from near the village of Gorse to the city, a distance of about six French leagues. About twenty arches of this great work still remain. Naval fights were frequently exhibited on water supplied by this aqueduct.

The two great modern schemes for supplying the metropolis with water are those of Mr. Bateman and Messrs. Hemans and Hassard. The former gentleman proposes to bring the water from the Welsh hills—the sources of the Severn—a distance of 183 miles; the other project is to bring the water of the lakes in the north of England, a distance of 240 miles from London. As to the respective merits of these bold projects we offer no opinion. The question of an abundant supply of pure water to the metropolis is one whose importance is becoming every day more and more felt, and we trust that after the Reform question is settled, the Government will turn their immediate attention to the future water supply of London.

ON THE BOTANICAL ORIGIN OF WHEAT.

BY JOHN R. JACKSON,

Curator of Museum, Royal Gardens, Kew.

THE origin of species is a subject which has recently occupied the attention, more or less, of every thinking man. The opening of this question is chiefly due to Mr. Darwin, the appearance of whose book some few years since caused such a sensation in the scientific world. What changes or variations have been proved or supposed to have taken place in the animal kingdom we are not prepared to discuss; we know that a strong inclination prevails amongst many, perhaps most, botanists of note to accept Mr. Darwin's theories abstractedly, if not in their entirety, and lumping is more in fashion just now than splitting. No doubt much good will be derived from this system, which is now being adopted in most botanical works of authority, and it will help much to facilitate the study of plants to a beginner. It is an old story how that our choice cultivated forms of apples look to the common crab as their first parent, or the numerous varieties of plums came from one common stock. These are facts which, having become popularly known, are consequently accepted as true; but the question as to the origin of the most important of all the cultivated plants of Britain, namely, the wheat, is one of very

difficult solution. That wheat was known in very ancient times is admitted by all; but from what country it originally came, as well as from what plant it originally sprung, is still a controverted point. The cultivation of wheat, as we all know, is coeval with the history of agriculture itself. It is said to have been found wild in Asia Minor, but great doubt exists as to its native country.

Wheat is now known to the botanist as *Triticum vulgare*, of which, however, there are a whole multitude of cultivated varieties. The most prominent or best distinguished forms are *T. æstivum* (Lin.), *T. hybernum*, and the spelt wheat, *T. spelta*. Of the genus Triticum we have two species natives of Britain, *T. repens* and *T. caninum*, under which the other species formerly described in British Floras are now sunk. The first of these, the couch-grass, is a common and too well-known plant to agriculturists, owing to the great difficulty experienced in extirpating its long creeping roots, which exhaust and impoverish the ground. *T. caninum* comes nearest to it in point of botanical characters, and the best means of distinguishing the two is by the fibrous root of the latter, compared with the creeping rhizome of the former. *T. repens*, however, has shown itself to be capable of changing its characters considerably in different situations. In some the awns are found bearded, while in others they are beardless.

A field of corn is always a pleasant sight, even when the blades have only just sprung from the ground, and are fresh and green with vigorous growth; but when the flower-spikes have reared their lofty heads often to a level with our own heads, and have changed their colour from green to the characteristic golden brown, and have become weighted with their heavy seeds, bowing with every breeze, a corn-field is in its greatest beauty, and is justly one of the happiest additions to an English landscape.

The question as to what was the original or wild state of wheat is one of very great interest, and one which has occupied the attention of many botanists, both British and foreign. Much has been written, and, perhaps, more especially by continental botanists, to establish the theory of the origin of wheat from *Ægilops ovata*, and, on the other hand, to refute it. Amongst English botanists, the late Professor Henfrey paid particular attention to the subject; but it would seem that the idea of *Ægilops triticoides* being a hybrid production of *Ægilops ovata* was first made known by Dr. Regel, of the Imperial Botanic Garden, St. Petersburgh. Experiments that have since been conducted in crossing these plants with wheat have proved satisfactory, so far as the greater development of the plants could be anticipated in so short a space of time,

though, on the contrary, we have records of similar forms of grass being under cultivation for four years, which, though they produce fertile seeds, never had the least apparent inclination to become wheat.

M. Fabre, of Agde, has conducted some most interesting experiments in the production of wheat from *Ægilops ovata*, the results of which were a taller growth of the plants generally, a greater development and enlargement, as well as a more regular growth of the ears, and a consequent enlargement of the seeds; indeed, we have seen some seeds of *Ægilops ovata* that would even pass muster for the immature seeds of a poor description of wheat. The chaff-scales also under cultivation modify their character to that of wheat, and the number of awns are likewise lessened. Thus M. Fabre has endeavoured to show that *Ægilops triticoides* is produced from *Ægilops ovata*, and in a further period of about six years that wheat can be produced by cultivation from *Ægilops triticoides*. As a still further proof of the accuracy of these experiments, we may quote the following account of a similar trial made and recorded by Professor Buckman, then of the Royal Agricultural College, Cirencester:—

"In 1854, we planted a plot with seed of *Ægilops ovata*, from which was gathered seed for a second crop in 1855, leaving the rest of the first plot to seed itself, which it did, and came up spontaneously. This plot has since continued to bring forth its annual crop in a wild state in which the spikes are short, and so brittle that they fall to pieces below each spikelet the moment the seed is at all ripe. The produce of the 1855 crop has, in the same manner, been cultivated year by year in different parts of the experimental garden of the Royal Agricultural College, and our crop for 1860 had many specimens upwards of two feet high, and with spikes of flowers containing as many as twelve spikelets. Our conclusions then are, that with us the *Ægilops* is steadily advancing, and we fully expect in three or four years to arrive at a true variety of cereal wheat. What, too, is confirmatory of this matter is, that the bruised foliage of the wild grass and the cultivated wheat emits the same peculiar odour; and, besides, the *Ægilops* is subject to attacks of the same species of parasites."

These parasites are small microscopic fungi, known to the agriculturist as rust, mildew, etc., or more commonly spoken of as blight. "These," Professor Buckman continues to say, "seem to be the effects of civilization; and it is not a little remarkable that, in this respect, this grass should be so much like our field crops, which were particularly liable to blight in the straw and foliage during 1860."

Ægilops triticoides has by many botanists been referred to

a hybrid form of *Ægilops ovata*, and from its nature and habit it seems to stand between it and wheat, and thus form a connecting link, for the plants are found mostly on the borders or in the neighbourhoods of corn-fields, and never in situations far removed from cultivated wheat; and the fact of its being scattered about in small quantities in different localities in the south of France would seem to indicate that corn-fields existed in the neighbourhood at one time.

Dr. Godron, a continental botanist, who has paid some attention to this subject, says:—"It is well known that the spike of *Ægilops ovata* breaks at its base when mature, that it does not become separated into pieces, and that it preserves its seed tightly fixed to the floral envelopes. This spike is introduced into the soil all in one piece, and the four seeds it contains give birth in the following year to four plants of *Ægilops*, distinct from one another, but with their roots interlaced, and forming by their union a little tuft. Ordinarily, all these seeds produce the parent plant; but sometimes one of the seeds gives birth to a plant very distinct from the first, and having an aspect which reminds us of cultivated wheat. This is *Ægilops triticoides*. This very interesting fact, ascertained by M. Fabre, I have often verified in the vicinity of Montpelier. M. Fabre took the resolution of sowing the seeds of *Ægilops triticoides*, and followed through twelve successive generations the products furnished by the seeds originally gathered from this wild grass. The plant assumed by slow degrees a taller growth, the spike became larger, it ceased to be brittle at the base, its glumes lost one of the two awns which distinguish *Ægilops triticoides*; in a word, this plant acquired, in part at least, the characters of wheat."

Dr. Godron, however, seems to be opposed to the theories of M. Fabre, and himself conducted a series of experiments, which, according to his showing, bore out his views. He says that it is "evident that *Ægilops triticoides* is nothing else than a hybrid resulting from the accidental fertilization of *Ægilops ovata* by *Triticum vulgare*, and in support of this proceeds to describe the results of his experiments. The first was made by scattering the pollen of *Triticum vulgare muticum* over the spikes of *Ægilops ovata*, in which the flowers were about to open, and at the period when it penetrates more readily into the flower, from the fact that the glumellæ of the *Ægilops* separate naturally to about the twenty-fifth of an inch. Out of six spikes so operated upon, and which were carefully gathered as soon as ripe, and the seeds sown in the following spring, five of them produced *Ægilops ovata* exclusively, the remaining one also produced stems of the same: "but one of the seeds gave birth to two stems much taller than those of

the parent plant, and the spikes of these presented the most perfect resemblance to those of that variety of *Ægilops triticoides*, in which the awns are half abortive, and as it were rudimentary." The second experiment was conducted by carefully opening the glumellæ of the *Ægilops* to such an extent as to admit a fine pair of forceps, and with these to extract the stamens and substitute the anthers of *Triticum vulgare muticum*. These anthers were selected from those just ready to open, so that the foreign pollen might be taken at once by the stigma. After the insertion of these anthers, the flowers were gently pressed together again, and left to fertilize. The result of this experiment was the production of plants of *Ægilops triticoides* from all the seeds ripened from the flowers experimented upon. The third experiment was conducted by removing the anthers from four spikes of *Ægilops ovata*, and replacing them with the anthers of *Triticum spelta barbatum*, the result of which was the production of a new hybrid, not one having the characters of the parent plant. From these results Dr. Godron arrives at the following conclusions:—1st, that hybrids may be obtained spontaneously from grasses, *Ægilops triticoides* being the first example known amongst them; 2ndly, that *Ægilops* and *Triticum* have not sufficiently distinguishing characters to separate them, and consequently must be considered as one and the same genus; 3rdly, that the conclusions of M. Fabre that the origin of wheat is to be traced to *Ægilops ovata*, or that one species can be transformed into the other, has not sufficient evidence to support it.

After such careful experiments and lucid reasoning from M. Fabre on the one hand and Dr. Godron on the other, many might be almost inclined to confess themselves converts to both opinions, though the arguments of M. Faber seem to us to have the greatest weight. We are continually having fresh proofs of the variation of species, and we know perfectly well what great changes are produced in plants by cultivation. We know, also, how distinct and numerous, even in wheat itself, the varieties are, and these distinctions are the effects of cultivation. Besides this we have abundant proofs of extraordinary changes and developments in nearly all our kitchen-garden plants. The potato, for instance, is one of the best examples of this, for, with all our fine and choice varieties, it is but the offspring of a small tuber having a bitter taste, a native of Chili and Peru. Our carrots, turnips, etc., in their wild state, are uninviting woody roots, and, in short, our gardens are filled with similar examples.

Having, therefore, so many proofs of the mutability of species, and the experiments of M. Fabre and Professor Buckman to help us, we look upon the theory of the origin of wheat

from *Ægilops ovata* as a very likely solution of the question. At the same time we would strongly recommend those who have doubts on the point to repeat the experiments for their own satisfaction, from which even now some fresh ideas might be had or knowledge obtained.

LUNAR PERSPECTIVE.

BY W. R. BIET, F.R.A.S.

Every observer of the moon's disc is well acquainted with the apparent changes which the features undergo from time to time, especially those near the margin; sometimes they appear close to the edge of the disc, and at others they are removed to a moderate distance from it, considerable alterations of form accompanying these oscillations of position. As these changes, both in position and form, depend upon the phenomenon known as the moon's libration, it may not be uninteresting if we attempt to explain the principles upon which they are effected.

The fundamental idea to be apprehended is simply this. At any given moment a line will join the centres of the earth and moon, and as both bodies are globular, this line will cut through a point in the surface of each. At the point on the earth's surface cut by this line let an observer be placed, and at the point on the moon's surface let there be a spot that can have the earth in its zenith. Rhæticus, which is situated on the moon's equator, is such a spot, and it is clear that, in the case suggested, Rhæticus and the observer will be respectively in each other's zenith, the crater occupying the middle of the moon's disc as seen from the earth. From this it will necessarily follow that the observer on the earth, looking through his telescope, directed to the zenith, will see the crater Rhæticus of nearly its *true* form, for the depth of the crater being very minute, as compared with the distance of the observer, perspective will scarcely interfere.

The perception of the true form of Rhæticus, with its interior shelving sides, will, however, be but momentary, viz., at the time of the moon's passing the meridian. While she is E. of the meridian the observer will see the interior E. slope *wider* than when looking directly into the crater at meridian passage, the interior W. slope being foreshortened. After meridian passage, the E. slope is foreshortened and the W. is viewed more directly, and from these phenomena it may be easily deduced that every object on the moon's surface under-

goes apparent changes of shape as well as position—within narrow limits—during the moon's passage above the horizon; and, near the margin, objects that were invisible at the time of the moon's rising, will be seen at the time of her setting. This phenomenon is called the diurnal libration.

The condition of Rhæticus being in the zenith of an observer on the earth, depends on the moon's passage of either the ascending or descending node, but as the passage of the node may occur with any degree of the moon's declination north or south, the observer who has had Rhæticus in his zenith in one lunation will not have it in the next; he may be either N. or S. of the point on the earth's surface cut by the line joining the centres of the earth and moon. In one case, the N. interior slope will be foreshortened; and in the other, the S. interior slope.

This foreshortening in a N. and S. direction will be augmented by the positions of observers on the earth's surface, in proportion as they are removed from the earth's equator. In high latitudes, and towards the poles, where the moon attains but a low altitude at meridian passage, the greatest foreshortening of lunar objects will be observed, especially in those regions which are removed farthest from the eye, in consequence of the inclination of the moon's equator to the plane of the earth's equator. From this it follows, that no two observers on the earth's surface will see any given lunar object of exactly the same form, or in exactly the same position on the disc.

The above-mentioned changes in form and position are slight compared with those that result from the inclination of the moon's orbit and axis to the ecliptic, combined with the varying velocity of her motion in her orbit. Bearing in mind that the line joining the centres of the earth and moon will cut different points of the surfaces of both bodies at different times, it is evident that a spot, such as Rhæticus, will have an oscillatory motion, or one allied to it, during every lunation, or interval from one new moon to the succeeding. It is when the moon is in either node that Rhæticus will be seen on a line dividing the apparent disc into two equal parts. As the moon moves N. of the ecliptic Rhæticus appears to move on the moon's disc towards the N., and the regions in the neighbourhood of the moon's south pole come into view, the result being that Rhæticus, with all the objects in the moon's N. hemisphere, are more foreshortened than at the time of the passage of the node, while those in the S. hemisphere are less, a few coming into such positions that they may be viewed in the zenith at meridian passage without foreshortening.

As soon as the moon has attained her greatest N. latitude she begins to return towards the ecliptic, and at the same time

the spots in the N. hemisphere commence their return to the equator of the apparent disc, becoming less and less foreshortened in their progress. After the moon has passed her descending node certain of the N. objects are seen on the S. part of the moon's disc; and they, with all the spots in the S. hemisphere, become more foreshortened until the greatest S. latitude is attained. At this time the regions about the S. pole, which were seen when the moon was in the opposite part of her orbit, are concealed, and corresponding regions in the neighbourhood of the moon's N. pole become visible. Upon the moon's return towards the ecliptic, with a motion from S. to N., all the objects on her surface partake of the same, the N. polar regions are gradually concealed, while the S. polar are as gradually brought into view. From these phenomena it follows that during the period that the moon's latitude is becoming more and more N., viz., from her greatest S. to her greatest N. latitude, the whole of the objects on her surface, visible to the earth, have a motion across her disc in the same direction, *i.e.*, from S. to N., some going out while others are coming into view, and during the period that her latitude is becoming more and more S., viz., from her greatest N. to her greatest S. latitude, the same objects have a motion from N. to S. This libratory motion is called the moon's libration in latitude, which may be rendered more intelligible by the annexed diagram (Fig. 1), in which *E* will represent the centre of the

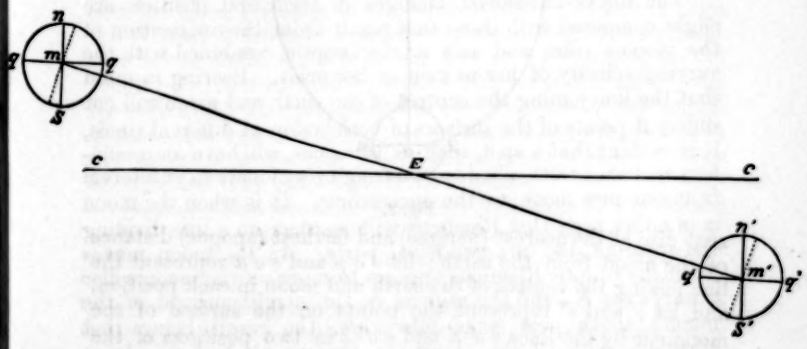


Fig. 1.

earth, *n s* the moon's N. and S. poles, *q q* the moon's equator, *m E* the line joining the centres at her greatest N. latitude, and *c e c* the ecliptic; the accented letters have the same signification when the moon is at her greatest S. latitude, the dotted line in each case represents half the boundary of the visible

disc by which the alternate visibility and concealment of the polar regions are rendered evident.

While the change of latitude produces an oscillation of the spots from N. to S. and *vice versa*, accompanied by alterations of form, the change of velocity of motion occasions a similar oscillation from W. to E. and the reverse. Popularly speaking, the moon always presents the same face to the earth, but as in one part of her orbit, that which is nearest to the earth, her motion is quickest, and in the opposite, that which is farthest, her motion is slowest, it is clear that unless the point on her surface cut by the line joining the centres of the earth and moon could accommodate itself to this varying velocity it must sometimes be to the W. and at others to the E. of a given point. Let the ellipse *p c a c'* (Fig. 2) represent the moon's orbit; let *o* be the given point which will occupy the centre of the appa-

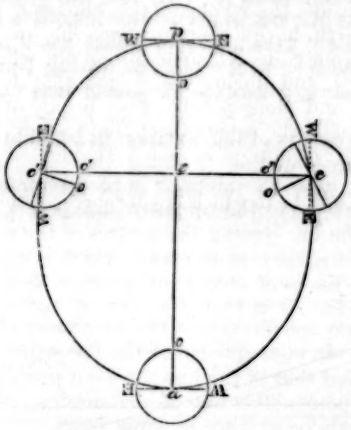


Fig. 2.

rent disc at the nearest (perigee) and farthest (apogee) distance of the moon from the earth; let *e o p* and *e o a* represent the line joining the centres of the earth and moon in each position, and let *o'* and *o''* represent the points on the surface of the moon cut by the lines *e o' c'* and *e o'' c* in two positions of the moon, one intermediate between apogee and perigee, the other intermediate between perigee and apogee. When the moon is beginning to move quicker than the mean motion, the point *o* is W. of the centre *o'* of the apparent disc W. *o o'* E, but as she comes up to perigee the point *o* is gradually transferred towards the E., and occupies the centre of the apparent disc, at the time of perigee when the motion is quickest; but while it

continues *quicker* than the mean, the point *o* is transferred still further towards the E., arriving at its limit when the moon's motion begins to be slower than the mean, after which the motion of the point *o* is towards the W., occupying the centre of the visible disc at the time of apogee, and proceeding still further W. until the motion is beginning to be quicker than the mean. It is to be noted that the *regularity* now described is greatly interfered with by the libration in latitude.

That which is true of one point on the surface is true of every other, so that all objects partake of this change, moving E. during the period the moon is moving quicker, and moving W. while she is moving slower than her mean motion, and from this it follows that during the period of her quicker motion certain objects near her E. margin are concealed, while other objects near her W. margin are brought into view. On the other hand, while passing through the slower part of her orbit objects near the E. margin come into view while those near the W. are gradually concealed. These changes of position, which are accompanied by changes of form arising from a greater or less foreshortening, constitute the phenomenon called libration in longitude.

As general results of the libration in latitude and longitude it may be briefly stated—

First. That when the moon is in perigee or apogee at the passage of either node the apparent disc is in a state of mean libration, for the line joining the centres of the earth and moon cuts the moon's equator in the point which is equidistant from the W. and E. limits of change of position arising from libration in longitude. It is from the line at right-angles to the equator (the first meridian) that the longitudes of lunar objects are reckoned. In consequence of the inequality of the motion of the nodes, and that of the line *p o e o a* joining the perigean and apogean points (the line of the apsides), a state of mean libration can only occur once in three years.

Second. That when the moon has N. latitude all the objects on her visible surface are N. of their *mean*, or normal positions, and that when she has S. latitude they are S. of these positions.

Third. That while the moon is moving from apogee to perigee all objects on her visible surface are W. of their normal positions, and that while she is moving from perigee to apogee they are E. of these positions.

It may from these data be easy, by means of lunar maps, and taking from the *Nautical Almanack*, for any given time, her latitude, and the sides of her orbit, to form a tolerable idea of the apparent surface as to the proximity to the margin, or otherwise, of the most salient features.

In applying the above-mentioned principles and phenomena

to the illustration of lunar perspective, it is essential to change the line joining the centres of the earth and moon, for one joining the eye of the observer and the moon's centre. It is clear that in this, as in the former case, the point on the moon's surface cut by this line will be the centre of the apparent disc, and here it may be proper to remark that the numerical expressions of the values of the libration of the apparent disc in latitude and longitude have reference *only* to the centre of the apparent disc, as seen from a given point on the earth's surface at a given time. These expressions are simply the latitude and longitude of this centre—thus, if the libration in latitude be equal to 3° N. and that in longitude to 2° W., the meaning is that the centre of the apparent disc is 3° N. of the equator, and 2° W. of the first meridian—the equator being S. of its normal position and the first meridian E.

Returning to the consideration of perspective. The smallest amount of foreshortening takes place at the centre of the disc, and as the observer is looking upon a globe, the foreshortening rapidly increases towards the margin in every direction. Lunar objects are of all conceivable shapes and sizes, from the extensive *Maria* to the smallest discernible hillocks and pits. They will, however, undergo apparent changes of form and position, in accordance with well recognized laws. Most objects of any size will—as they are found near to or removed from the margin—be presented to the eye under elliptical forms, generally of great irregularity, all the shorter axes being directed towards the centre, and all the longer axes being portions of curves more or less concentric with the margin. In consequence of the inequality of the moon's motions, above-mentioned, the approach and recess of the spots towards and from the margin are very irregular, bringing prominently into view at some seasons certain features, and at others concealing them; thus it arises that no two drawings of a lunar object at different epochs, by the same observer, or by two observers, even at the same epoch, agree fully in detail. It is true that an experienced eye will detect manifest errors, but with the most assiduous attention capable of producing the most scrupulous accuracy, differences must occur as the results of differing perspective. This is very evident from an inspection of a collection of photographs taken at different states of libration. The well-known elliptical spot the *Mare Crisium* is seen, when the moon is moving from apogee to perigee, to approach somewhat closely to the margin, the surface in the direction of the shorter axis being much contracted, and in a particular position the N. boundary appears as a *straight* line of mountains. During the period when the moon moves from perigee to apogee the *Mare Crisium* attains its greatest distance from the margin, the finely

variegated surface is brought more directly under the eye, many objects become visible that could not be seen when, by its proximity to the margin, it was greatly foreshortened. The N. boundary presents a very different appearance, being both curved and indented by numerous bays and valleys; indeed, representations of this interesting region at the two extreme epochs differ amazingly from each other. It is curious to notice the remarkable and totally unexpected changes in form that many spots present under these extreme conditions, and when watched from night to night, and from season to season, the gradations of change are highly interesting. As instances we give two drawings of the well-known walled plain "Plato," affected considerably by libration in latitude.

The engravings represent the Lunar Crater Plato, as seen under two different states of libration. The drawing of Fig. 3

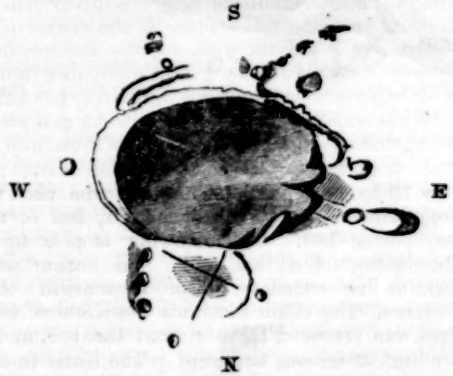


Fig. 3.

was made in 1863, at Hartwell, on January 11, between 13 and 19 hours, G.M.T. The telescope used was the equatorial of 5·9 inches aperture, powers 118 and 240. At the time the drawing was made, Plato was under the evening illumination, the moon having attained her greatest libration, the quadrant in which the greatest change was observed being the S.E. At this time the moon's latitude was about 4°·50′ *South*, bringing Plato nearer to the eye of the observer, so that the elliptic form of the crater was *widened*, all objects being south and west of their mean places. The prominent features in the drawing are—1st. The bright interior of the west wall of Plato. 2nd. The indented shadow of the east wall. 3rd. A formation on the north of Plato, bounded on the west by a mountain range. On the surface of this formation are two rills crossing

each other. 4th. On the S.W. of Plato is a mountain range projecting from the mountainous border of the crater. This mountain range is the *highest* in the immediate neighbourhood, its shadow being the *last* to be observed on the surface *outside* the S.W. rim of Plato.

The drawing of Fig. 4 was made in 1863, at London, on

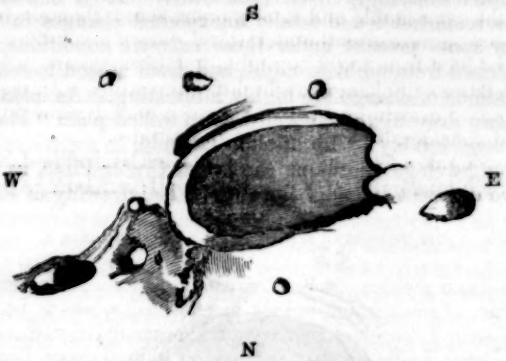


Fig. 4.

July 6, 13 to 15 hours, G.M.T. The telescope used was the Royal Astronomical Society's Sheepshank's, No. 5, aperture 2·75 inches, power 150. This drawing is also under the evening illumination, but the moon had not attained her greatest libration; nevertheless, objects were north and east of their mean places. The moon's latitude was about 4°·40′ *North*, so that Plato was removed further from the eye, and consequently its elliptic form was *narrowed*. The libration in longitude having carried objects further east, Fig. 2 is differently circumstanced to Fig. 1. The prominent features in Fig. 1 are, however, well recognized in Fig. 2. 1st. The bright interior of the W. and S.W. wall, but rather *differently* illuminated. 2nd. The indented shadow of the E. wall. This feature presents a great difference in the two drawings—the crag, or tongue, which projects inwards from the N.E. in a S.E. direction in Fig. 1 is wanting in Fig. 2, and the shadows are not so broad, the difference between the epoch of observation, and that of sunset, being greater in Fig. 2 than in Fig. 1. 3rd. The formation on the north was not drawn, except the mountain range forming its west border, which, in Fig. 2, is *straight*, instead of being *curved*, as in Fig. 1. A few objects are given in Fig. 2 on the N.W. not in Fig. 1. Of these, the north edge of Plato, the mountain and crater in a line with it, and the south edge of the crater on the east, were ascertained to be

in the same line. 4th. The mountain range on the S.W. presents the same character in both drawings.

The cardinal points are only approximately placed to indicate the general position of the crater and the surrounding objects, and are not to be taken as showing the true bearings. The crater on the N.W., the ϕ of Schröter, is remarkable. On several occasions I have observed a dark nebulosity surrounding a dark spot in the middle of the shadow. I am not certain of the precise nature of the crater.

RED STAR.—DOUBLE STARS.—NEBULÆ.—LINNÉ AND ARISTOTELES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

It is now many years since, in consequence of a statement that a red star, of remarkable beauty and intensity, was to be found *f a* in *Hydra*, I searched that region repeatedly in vain. I was subsequently informed that my *pointer* should have been designated *a Hydræ et Crateris* (better, surely, *a Crateris* alone, for there is no other *Crater*, and *Hydra* is of itself more than sufficiently extensive). The region being now in sight at a convenient hour, I determined upon a search with my beautifully-defining 9¼ inch "With" speculum, during one of the very few evenings (March 27) which have admitted of the employment of a telescope during many weeks. The position of *Crater*, near the meridian, was easily made out, as a group not many degrees above the horizon, preceding the four conspicuous stars of *Corvus*, which in turn precede, though at a much lower elevation, the brilliant *Spica*. It composes a long and rather narrow trapezium, extended E. and W., and formed by two unequal lines, of two stars each, the lower line being shorter than the upper at its W. end. The star, whose displacement towards the left, so to speak, turns into a trapezium what would have been a parallelogram, is the *a* in question. But it certainly does not deserve that appellation. Of the four stars (as far as a rapid comparison enables me to speak) the brightest was the uppermost to the W.; this, however, though included in *Crater* in the larger maps of the S.D.U.K., and marked there with Flamsteed's figure 4, as belonging to that asterism, is referred by Argelander, one of the highest authorities, to *Hydra:* but the 2nd in the upper line, δ *Crateris*, is much superior to *a*, and γ, to the left below, about equal to it. It has been shown that Bayer, whose Greek designation

of the stars was published in 1603, was guided in some cases by position, as in others by magnitude, and this enfeebles the presumption of variable light which would otherwise arise in many constellations: and, in the present instance, *a* certainly stands first in R.A., among the lettered stars of *Crater;* still, had it been then as inferior to δ as it is now, it seems hardly likely that he would have so distinguished it. In the adjacent *Hydra* he has evidently had the order of brightness in view. In the S.D.U.K. map, δ has 3rd, *a* and γ, with *ν Hydræ*, 4 mag. Argelander gives *ν Hydræ* and δ 3·4, *a* and γ, 4 mag. It seems desirable that variable light should be looked for here: *a* may have diminished, or δ increased, or both.

Having found *a Crateris*, we let him pass through the field, and we shall find him followed, at 42·5s, 1′*s*, by his ruddy attendant, whose hue is certainly very striking, and much resembling that of our acquaintance R *Leonis* (see our March number). It is, however, small enough to require a fair aperture to exhibit its colour well. Baxendell has found it variable, considering it, April, 1866, fully ¾ mag. smaller than during the spring of 1865: and hence he has designated it, according to Argelander's system, as R *Crateris* (implying that it is the first variable discovered in that constellation, the letter S being reserved for the next, and so on). At a short distance from the red star, and on a line pointing but a little *s* of *a*, there is a somewhat smaller one, which I found of a decidedly blue tint. It would be interesting to ascertain whether its hue was the effect of contrast; but this would be better done with a very large aperture, and the contracted field of a Dawes' eye-piece; my impression certainly was that it was blue rather than green, the complementary tint; and that its colour was, therefore, in part at least, independent. No time should be lost in looking for this group, now rapidly passing away.

It has been repeatedly remarked that a ruddy tinge is often associated with variable light. Such is eminently the case with R *Leporis* and R *Leonis*, to which may be added another remarkable instance, R *Cassiopeæ*, which, according to Pogson, is vividly red. It lies in R.A. xxiiih. 51m. D.N. 50° 35′, and varies, according to Professor Schönfeld, somewhat uncertainly as to brightness, sometimes rising to 4·8, at others only to 6 mag.: the period also may be shortening, as before 1865 he thought it had been 449 d., but in that year it appeared to be 430 d.; and at its next return, 412·5 d. From the two previous *maxima*, 1865, Feb., 21·5; 1866, Apr. 10, the next may be expected to occur between May 7 and May 10, on the supposition of an equable acceleration. This, however, is most improbable, as the period would thus, in a few years, become = 0, instead of being expressed, like all similar alternations, by an undula-

ting curve of more or less regularity. We shall, therefore, expect to find that the *maximum* will be retarded beyond this epoch, though it may probably fall within the month. If the acceleration has reached its limit for the present, it will take place about May 27 or 28; but in the existing absence of more reliable data, it should be watched from the 7th to the end of May.

The present may be an appropriate place for introducing the mention of two *Red Stars* not included in Dr. Schjellerup's catalogue of those objects, in No. 1591 of the *Astronomische Nachrichten*, or in the list given in our number for Sept. last. Mr. Lassell states, in the *Monthly Notices*, xvii., 65, that on Sept. 5, 1857, while sweeping about Cygnus, with his 2f. mirror, and admiring, with power 160, the wonderful richness and splendour of the milky way, he discovered what appeared to him the deepest red star he had ever seen, 9½ mag. R. A. xxih. 16·6m., N.P.D. 48° 13′: while in R.A. xxih. 37m., N.P.D. 52° 42′ is another deep-red star, rather brighter, 8 mag.

DOUBLE STARS.

The acquaintance we have made with *ν Hydræ* will enable us by his means to fish out two objects in the same neighbourhood, which, though telescopic, being easily found, may be admitted into our long discontinued list of Double Stars. Resuming our former arrangement, the first will stand as

158. P. x. 159 *Hydræ*, 31″5. 10°. 8, 9. Pale white and light blue; less than 1° *n p ν Hydræ*. This pair, though pretty, points, nearly, to a much finer object, about 22′ *n*;

159. Σ 1474 *Hydræ*; a beautiful triple group, of which the data, according to Σ, are: A. 6·9, B. 8, C. 7·7 mag.—A.B. 71″67, 22°22.—C.B. 6″38, 196°14.—Very white.

NEBULÆ.

In our number for last November, mention was made of certain nebulæ to which a suspicion was attached of variable light. In Rümker's *Hamburg Catalogue of Circumpolar Nebulæ*, recently completed, two more instances occur, which may with propriety be included in our list of these objects; since, having been observed with only a 5f. telescope, they are within the reach of a large proportion of astronomical students. The first is (resuming our own numbering):—

33. Gen. Cat. 4351. R.A. xvii h. 50m. 54s., D.N. 70° 10′ 48″. Of this, which was discovered by Auwers 1854, July 24, and considered by him pretty faint, Rümker made four observations, 1866, Oct. 5, 6, 7, 11; in the three first of which it is expressly called "bright," or "very bright." It

is 3—4′ long, 1′ broad, and with a darkness in the middle, so as to convert it into a double nebula, of which the *n p* portion is the brighter, and the axis inclined 20° to the parallel. The other nebula is:

34. Gen. Cat. 4415. R.A. xviii h. 23m. 35s. D.N. 71° 30′ 12″. Discovered by Tuttle (America) 1859, Sept. 1. The possibility of variation here had already been pointed out by H. on a ground repeated by Rümker, namely, that D'Arrest had seen it in a comet-finder, 1862, Sept. 24, so large and so bright, that in a similar condition it could not have escaped M., $H_{\odot}$., or H. When we bear in mind the insufficiency of M.'s optical means, which led him to assure himself that the glorious nebula in Hercules contained *no stars*, the brightness, in 1862, of an object which, in the opinion of so great an authority as D'Arrest, could not have escaped his notice, is very striking. We must not, however, forget that the great light and expanded field of a comet-finder would give it a very different aspect. When observed by Rümker, 1866, Oct. 4, 5, 6, 7, it was entered as pretty faint, or only moderately bright, and he remarks that, in the field of an ordinary comet-finder, it would have been seen with great difficulty, or only in consequence of its juxtaposition with two 11 mag. stars *p*. at a short distance. It would be an interesting object of study.

To these we shall add two others, not very distant from the region of our red star, which we must look for with little delay, in consequence of their small meridian altitude and the advancing season.

35. *The Gaseous Nebula in Hydra.* Gen. Cat. 2102. $H_{\odot}$. iv. 27. Sm. describes this as a pale, greyish-white, planetary nebula, resembling Jupiter in size, equable light (not, of course, *brilliancy*) and colour, with four telescopic stars surrounding it, a line between those *np* and *sf* touching the disc —a not unimportant remark, from the suspicions which have been entertained of the possibility, either of satellite-stars, or proper motion in nebulous masses. H., who includes it as No. 3248 in his S. catalogue, says it extends about 30″ by 25″, and is of a very bright, uniform light, and very decided pale blue colour, but not quite sharp at the edges. In 1851, with an aperture of $3\frac{7}{10}$-inches, I found it a very bright and beautiful object, so small with 64 that it might be overlooked in sweeping, but bearing increase of power wonderfully up to 250; the elliptical form, the haziness of the limb, and the blue tint, were all independently noticed; which is simply worthy of mention as an encouragement to the possessors of the smaller class of instruments. I now see it (1867, April 9) with the $9\frac{1}{4}$-inch mirror, as a very brilliant object; and the effect of increase of aperture is strikingly exemplified in its

enlarged diameter with the same power; it could not possibly be overlooked here by any imaginable amount of carelessness. It is, however, very probable that this effect is due in part to a greater decrease of light towards the edge than would be made sensible in any other way. It is singular how little power the most delicate vision has of detecting, at least under certain circumstances, gradual variations in brightness. This is undeniably and curiously exhibited in the case of Jupiter, whose disc, sensibly uniform in brilliancy, is shown to be much more brilliant in the centre by the frequent change in the aspect of the satellites during their transits. It is also exemplified in the telescopic discs of stars, which are known, from theory, to degrade rapidly in light from the centre, though this is only manifested to the eye by the different sizes of the discs in proportion to their luminosity. And it is more than probable that the uniformity of light ascribed by Sm. to this nebula and Jupiter is as illusive in the one instance as in the other. With this large aperture the edges were extremely woolly; the elliptic form and blue tint were not conspicuous, but there was some moonlight, and, probably, haze, and the meridian was long passed. With 170 and about 600, I fancied the light not very equable; but I was aware that Secchi had broken up the supposed uniformity of aspect: not in consequence of greater light, having only $9\frac{6}{10}$-in. achrom. against $18\frac{1}{4}$-in. front view reflection, but from higher power; H.'s 180 being the most suitable for his purpose of surveying the whole heavens; while Secchi, having a special design, was able to carry his even up to 1000 with great distinctness, and thus he perceived, within a circular nebulosity, two clusters connected by two semicircular arcs of stars into one sparkling ring, with a single star upon the hazy central area. Yet, as in the case of the annular nebula in Lyra, the appearance must have been deceptive, at least as to the existence of matter in a solid or even a liquid state. At such a distance the eye can take no direct cognizance of the nature of what it sees; but the prismatic analysis of light will still give information which, though indirectly obtained, seems fully to be trusted; and in this way Huggins, through his 8-in. object-glass, with powers of 600 and 920, detects the oval ring, which he thinks is seen obliquely by us within a globular mass of faint nebulosity, yet finds, from the quality of its light, decomposed into three bright lines, that it consists almost entirely of gaseous matter. With a wider opening of the spectroscope than would define the lines properly, he "*suspected* a faint and broad continuous spectrum," indicating the presence of some feebly luminous solid or fluid materials (or possibly small stars involved in the mass?). We have here evidently a structure not very dissi-

milar to that of the annular nebula in Lyra. To find it, we must run a line through the stars δ *Crateris* and *ν Hydræ* already described, bending it a little upwards; this will point out, at nearly an equal distance, *μ Hydræ*, a 4 mag. star of a glorious yellow hue, about 2° *s.* of which the nebula lies.

We shall find a curious contrast to this marvellous object in our next, which, however, will require a very transparent night, from its nearness to the horizon.

36. Gen. Cat. 3128. M 68. This Sm. calls a large, very pale, mottled nebula, 3′ × 4′ diam. H. describes it at the Cape at a much greater elevation, as an irregularly round cluster, gradually brighter in the middle, very ragged at the borders, all clearly resolved into 12 mag. stars. To me, with $3\frac{7}{10}$ inches, it was a rather faint, but, from its size, pretty conspicuous object, not bearing magnifying. A line will find it, run nearly vertically down through δ and *β*, the two bright *f* stars of *Corvus*. At about half their distance, it will point out a 5 mag. star, closely *n f*, which is the nebula.

The apprehension we expressed some time ago, that the light of the *Great Spiral Nebula*, M 51, No. 29 (Intellectual Observer, viii., 209) would be too feeble for prismatic analysis, has not been realized, Huggins having found the spectrum of each nucleus continuous, though with a suspicion that some parts were abnormally bright. Hence the stellar constitution ascribed to this marvellous system by the E. of Rosse seems verified. Apr. 11, intending to look for it, I came suddenly upon another object, at no great distance, which I took at first for a telescopic comet, but afterwards identified, and which may stand as—

37. Gen. Cat. 3474. M 63. R.A. xiii h. 9m. 32s. D.N. 42° 46′ 15″. Discovered by Mechain, 1779. Described by Sm. as an oval, milky-white nebula, with a nucleus like a small star. H found it very bright, 9′ or 10′ long by 4′ broad, with a very brilliant nucleus, which H. speaks of as almost stellar. It appeared quite so to me, about 10 mag.? (Σ) but I used no higher power than 239: with 65 and 111 I might have overlooked it. The nebula lies between a 7·5? mag. star *p*, and an interesting but very minute triplet 9·5? mag. *f*. It may be found by sweeping in a barren space, about half way between the last star of the Great Bear's tail, and *Cor Caroli*. Three nebulæ in *Scorpio* will repay our search, but we must watch for opportunities—long days, moon-light, and nearness to the horizon, being all against us. We take first—

38. Gen. Cat. 4183. M 4. This, according to Sm., is a compressed mass of very small stars, with outliers; elongated, and blazing in the centre; with a ridge of 8 or 10 pretty bright stars, running *n f* from the middle. We find it readily about

1¼° *p Antares*, a large but rather dim object. Sm. remarks that it stands on the W. edge of a starless area. Our next is—

39. Gen. Cat. 4173. M 80. Sm. calls it a compressed globular cluster of very minute stars; a fine bright object with a blazing centre, like a comet.* H styled it the richest and most condensed mass in the heavens. It was all resolved by H., at the Cape, into 14 and 15 mag. stars. A wonderful instance in itself of the mysterious arrangements of creative power, but deriving its chief interest from the fact that in the same position is a marvellous variable star. Neither M., H, H., Sm., Argelander, nor D'Arrest, had noted anything unusual here. Auwers, the well-known observer of nebulæ, had often seen this cluster in its ordinary aspect, in the spring of 1859, and even as late as 1860, May 18. By May 21, with a rapidity analogous to that of the variable in *Corona Borealis* (1866, May 12), or that of the Great Star of 1572, there had broken out in the place of the cluster a bright telescopic star, according to Auwers of 7, to Luther of 6·5 mag. It was the same the following night; by the 25th both found it rather smaller; and Pogson saw it of 7 or 8 mag. on the 28th. June 10, Pogson had lost it; but thought the cluster unusually brilliant and condensed. Auwers did not quite lose sight of it, and perceived that it was not central. It is barely conceivable that such an outburst should take place in the heart of a cluster, and leave it as before; and it is more natural to suppose that the objects are merely optically coincident; but the progress of discovery may well teach us caution in our deductions. In the same field with this cluster, *f*, a little *n*, are two undoubted variables, R and S *Scorpii*, discovered by Chacornac in 1853 and 1854, changing from about 9 to less than 14 mag., or invisibility; the former with a probable period of about 648; the latter, 364½d. Baxendell's remark, that these marvellous objects are apt to occur in groups, is strikingly exemplified here.

We shall readily find this cluster half way between *Antares* and *β Scorpii*, 2 mag., the brightest star of the group *n p Antares*.

40. Gen. Cat. 4261. M 62. Sm. calls this a fine large resolvable nebula, running up to a central blaze. H., at the Cape, who terms it superb, resolved it all into 14—16 mag. stars. We may find it from *δ Scorpii*, 3 mag., the most *s* star of the group *n p Antares*, by running a line back to *Antares*,

* The assertion of this usually most accurate astronomer, that it lies on the W. edge of a vast obscure opening without stars, 4° broad, may, perhaps, have arisen from some confusion with its neighbour, M 4. On two occasions I have seen, with only 3⅞ inches, many minute stars E. of it.

and carrying it on about an equal distance. It is, however, very low in our latitudes.

LINNÉ AND ARISTOTELES.

The evening of April 11 proving an exceptionally fine one during a most unfavourable season, I determined to examine the site of *Linné*, although considerably removed from the terminator, near which I have never yet had an opportunity of looking for it. The quadrature had taken place at 3h., and at 7h. 15m. (G.M.T.) the terminator bisected the ring of *Aristillus*, while the greater part of that of *Autolycus* was tipped with light. With my 9¼in. silvered speculum, and powers of 212, and the same raised considerably by a Barlow lens, I found the general definition something better than usual, but varied by short though frequently recurring intervals of great distinctness. It was not difficult to see that there was some marking in the white, ill-defined patch on the site of Linné; but its nature was not so readily made out. With close attention, I once or twice thought I saw the "ghost" described by Mr. Knott (*Astron. Register*, L. 33) as a pale ring, about as large, perhaps, as that figured by B. and M., a little brighter than the included or exterior surface. But this was seldom the case, and what was much more frequently and steadily seen was, not merely the black point described by Schmidt, but its character as the shadow in a very small crater, surrounded by a luminous ring of considerable proportional breadth. It seemed not more than $\frac{1}{3}$ as large as the nearest little crater to the N.W., *Linné* A of B. and M.—7h. 45m. Air not quite so good: power about 239: previous observation confirmed. The "ghost" ring and the minute crater cannot be seen both at once; but I think the pit lies at the W. side of the ring: this, however, is quite doubtful. It may be half the size of *Linné* A.—8h. 15m. Air worse; but once a pretty clear though transient view of the little crater. This result, under the circumstances, ought only to be received with caution: I would, however, record my full impression that the minute pit and its ring have an actual existence. It will be seen that the observation is in full accordance with that of Secchi, and differs somewhat from those of Schmidt; owing, it may be presumed, to the superiority of my powerful reflector, whose definition probably resembles more nearly that of the celebrated Roman achromatic, than that of the tarnished dialyte with which, nevertheless, so much admirable work has been done at Athens. But all results tend to establish the reality of Schmidt's claim, as the discoverer of an unquestionable instance of lunar change.

Such events will naturally lead to a closer scrutiny of minute

features. On the same evening, I found the crater on the summit of the western Γ, near *Aristoteles* (see the diagram in our Jan. number), extremely obvious, and the hill itself apparently not more than half as high as its neighbour, and casting much less shadow: the W. height of the group of three hills and three craters N. of Γ has also a shallow crater upon its summit; and the "irregularity" mentioned at that time in the crater B, is found to arise from a ring formed by a subsequent eruption in its interior; a very unusual feature in a crater of this size. At moments of best definition, the mountains exhibit plainly, in many places, the rough and spongy character ascribed to them by Chacornac, and the N. slope of *Aristoteles* is studded in many places with very minute craters, never seen before.

OCCULTATIONS.

The astronomical May 1st is remarkable for the occultations of the two planets Venus and Mercury; the latter of which, however, according to civil reckoning, falls on the 2nd. The dates are, Venus, 1h. 15m. to 2h. 20m.; Mercury, 22h. 53m. to 23h. 46m. Both being in broad daylight and near the sun, an equatorial mounting is necessary.—6th. 117 Tauri, 6 mag., 8h. 4m. to 8h. 41m.—17th. o^2 Libræ, 6 mag., 11h. 57m. to 12h. 59m.

GRAPTOLITES: THEIR STRUCTURE AND SYSTEMATIC POSITION.

BY WILLIAM CARRUTHERS, F.L.S.

Name. The name *Graptolithus* was first employed by Linnæus, in the original folio edition of his famous *Systema Naturæ* (1736), for certain natural objects, which he describes as resembling, but not being, true petrifactions. He included in this generic group ruin marble, dendrites, and fucoid and worm markings, but not a single form of the fossils to which the name is now confined. No change is introduced into the genus until the publication of the twelfth edition of the *Systema* in 1767. The thin folio* of the first edition, with its twelve pages, had been gradually increasing in the various

* The Stockholm Academy have resolved to reproduce this rare volume by photo-zincography, so that ere long it is to be hoped that the possession of a fac-simile of Linnæus's great work may be within the reach of every student of nature.

authorized editions, until in this, the last edited by Linnæus himself, it appeared in three octavo volumes, containing altogether 1504 pages. It is curious to look at the classification of fossils contained in this work, and notice how the science of Palæontology has grown during the century that has elapsed since the death of the famous Swede. Every known *true* fossil (in the modern use of the term) was classed under one or other of seven genera, depending upon whether it belonged to a (1) mammal, (2) bird, (3) reptile, (4) fish, (5) insect, (6) worm, or (7) plant. The genus *Graptolithus* was retained for a number of anomalous and puzzling bodies, which were, "properly speaking, not true fossils, though they were popularly referred to fossils." Of the seven species included in the genus in the first edition, two are here omitted (star-stones and stigmites), and three others are added; but of the eight species only *one* is a true graptolite. This he named *G. scalaris*, and the illustration and description on the 147th page of his *Scanian Travels* (1751) are quoted for it. As this is the first figure of a graptolite, we reproduce it here in fac-simile, and translate his short description. He says,

Fac-simile of the Figure of *Graptolithus scalaris*, Linn. From *Skanska Resa*, p. 147.

"Petrifaction or graptolitus of a curious kind, found in a slab of slate that had been broken to pieces, the black characters of which, upon the grey stone, resembled a line such as might be printed by a coin on its edge, and often terminate in spiral ends." This drawing and description have been very differently interpreted, and it is an interesting inquiry to ascertain what Linnæus meant by his original species. The spiral ends have certainly no connection with the linear fossil, but belong to a different species, most probably *G. convolutus*, His. All are agreed that the figure represents a graptolite preserved so as to show the cell mouths on its upper surface, and from this, specimens thus preserved have been called "scalariform impressions." Some hold that it belongs to a species with a single series of cells, but I believe that Hall more correctly

refers it to the group with a double series of cells. The figure is too broad for a species of *Graptolithus*, and the length and general aspect agree better with Diplograpsus, so that I do not hesitate, with Hall, to refer it to that genus. Moreover, Hisinger's *Graptolithus* (*Prionotus*) *scalaris*, collected in the same locality as that in which Linnæus obtained his fossil, is undoubtedly the species that was afterwards described by M'Coy under the name of *Diplograpsus rectangularis*.

Graptolithus sagittarius, of the twelfth edition of the *Systema*, has always been quoted as belonging to this tribe of fossils. I cannot imagine how Hisinger came to apply this name to a species of the restricted genus *Graptolithus*, with which Linnæus's description has not one character in common. The original species was founded on the drawing of the fragment of a *Lepidodendron*, a genus of fossil coal plants, in Volkmann's *Silesia subterranea* (1720), Part III., Tab. 4, Fig. 6, which is accurately described in the short diagnosis appended by Linnæus to his species. This error made by Hisinger has passed through all the works on Graptolites uncorrected, and has caused the Linnean generic name to be applied to the species with one series of cells, whereas the only species known to Linnæus was a Diplograpsus.

We would here object to a practice that has prevailed among some writers on this family of fossils of altering the spelling of generic names to suit their peculiar notions. Unless under very peculiar circumstances, the original spelling should always be retained, and as Linnæus wrote the generic name, *Graptolithus*, it ought to be so used. In his *Scanian Travels*, it appears as *Graptolitus*, but in the *Systema* he retains throughout the original spelling. The term Graptolites may be considered to be a useful English form of the word, and may be conveniently employed, as it has been by Barrande, as a common term for the whole family.

Structure. Believing, with the majority of those who have examined this family, that the graptolites are true Hydrozoa, I shall discard the nomenclature that has crept into use, adopted, as it has been sometimes, from supposed resemblances to plants, and sometimes from affinities to animals, and employ the terms that have been proposed by Huxley and Allmann, in their works on the recent Hydrozoa. As these terms have not yet got into general use, it will enable the reader better to follow the descriptions if I here give definitions of the few that it will be necessary to employ. The observations made within the last twenty years on the Hydrozoa, have shown that every hydroid exists under two separate forms, the one, the "trophosome," destined only for nutrition and growth; the other, the "gonosome," designed for the

reproduction of the species. The trophosome consists of a chitinous "polypary" that invests the "cœnosarc," or common connecting fleshy basis of the colony, as well as the individual "polypites," which are, in some tribes, protected by a specially developed receptacle, or "hydrotheca." The "hydrorhiza" is the root-like proximal termination of the polypary, by which the hydroid is attached to foreign bodies, and the "hydrocaulus" is the portion of the polypary that intervenes between the hydrorhiza and the polypites. In the *Sertulariadæ*, the "gonophores," or generative buds, are produced in a capsule, called the "gonangium."

The trophosome is the only form of the graptolite with which we are acquainted. Its polypary was composed of a flexible chitinous substance, like that of the recent hydroids. It is preserved either as a thin carbonaceous film between the layers of a fissile shale, which, on being split, presents an equally perfect impression on both surfaces, or second in the round in the same shale, when the whole organism is converted into iron pyrites, or third in limestone, where the fossil frequently retains its original form; and while the polypary is converted into a carbonaceous substance, the interior, originally occupied by the cœnosarc and polypites, is filled with the amorphous substance of the rock. I have made several sections of two species (*G. priodon*, Bronn, and *G. Roemeri*, Barr.), preserved in the round in limestone from Bohemia, and have also examined specimens of *G. Sedgewickii*, Portl., and *G. convolutus*, His., from the Moffat shales, retaining their natural form; and though the pyrites is more unmanageable than the limestone, I have determined that they all agree in structure. M. Barrande has accurately described the structure of the Bohemian species named. *G. priodon* (Plate, Fig. 1) is composed of a single series of hydrothecæ, the walls of which are in conjunction for nearly two-thirds their length, but the outer portion is free. In the longitudinal section (Fig. 15), the relation of the hydrothecæ to each other is more obvious. M. Barrande figures the separating walls as double, and though they must be so, I have not been able to detect, even with a high magnifying power, more than a single thin layer. In the process of fosillisation, all traces of the two walls have disappeared in the specimens I have examined, but its double nature is seen when, towards the mouth of the cell, it separates into two portions, the one to form part of the superior hydrotheca, and the other of the inferior. A free space exists between the base of the hydrotheca and the wall of the polypary, which was filled with the cœnosarc of the colony. This is the common canal of M. Barrande. There is no constriction, or septum, at the base of the hydrotheca, separating the indi-

vidual polypite from the common cœnosarc. M. Barrande describes an internal orifice as existing in this position, but his longitudinal section of *G. priodon* gives no indication of it, and his figures illustrating it in *G. nuntius*, Barr., and *G. Halli*, Barr., show that he has been misled by referring to these species scalariform impressions of a double graptolite. His internal orifices are the external openings of the under surface, showing themselves faintly through the chitinous investment of the polypary, while the external orifices are the series of openings preserved on the upper surface, which are consequently preserved with greater definition.

The back of the polypary was strengthened by a solid axis (Fig. 2) composed of the same substance as its walls. This is a distinct structure, and capable of being separated from the graptolite without destroying that surface to which it is closely applied. It is frequently continued beyond the cell-bearing portion of the graptolite as a simple naked axis.

The structure of *G. Roemeri* (Fig. 16) agrees in every respect with that of *G. priodon*, except that the walls of the neighbouring hydrothecæ are in contact throughout their whole length. In this respect there is a considerable variation among graptolites. In *G. convolutus*, His. (Fig. 14), the hydrothecæ are free throughout their whole length, while in Barrande's genus, *Rastrites* (Fig. 17), the individual hydrothecæ are not only free, but separated from each other by an interposed non-polypiferous portion of the filiform polypary. A very different structure appears to exist in *G. latus*, M'Coy, and *G. sagittarius*, His. Both these species have as yet, I believe, been found only in a flattened condition, so that the full meaning of the external appearances cannot be positively determined. In well-preserved specimens of both, there seems to be a septum at the base of each hydrotheca; and in *G. sagittarius*, I have noticed the divisions between the individual polypites passing down to the solid axis, leaving apparently no space for the common cœnosarc. The structure of the polypary may, however, have been similar to what will be presently described as existing in Hall's genus *Climacograptus*.

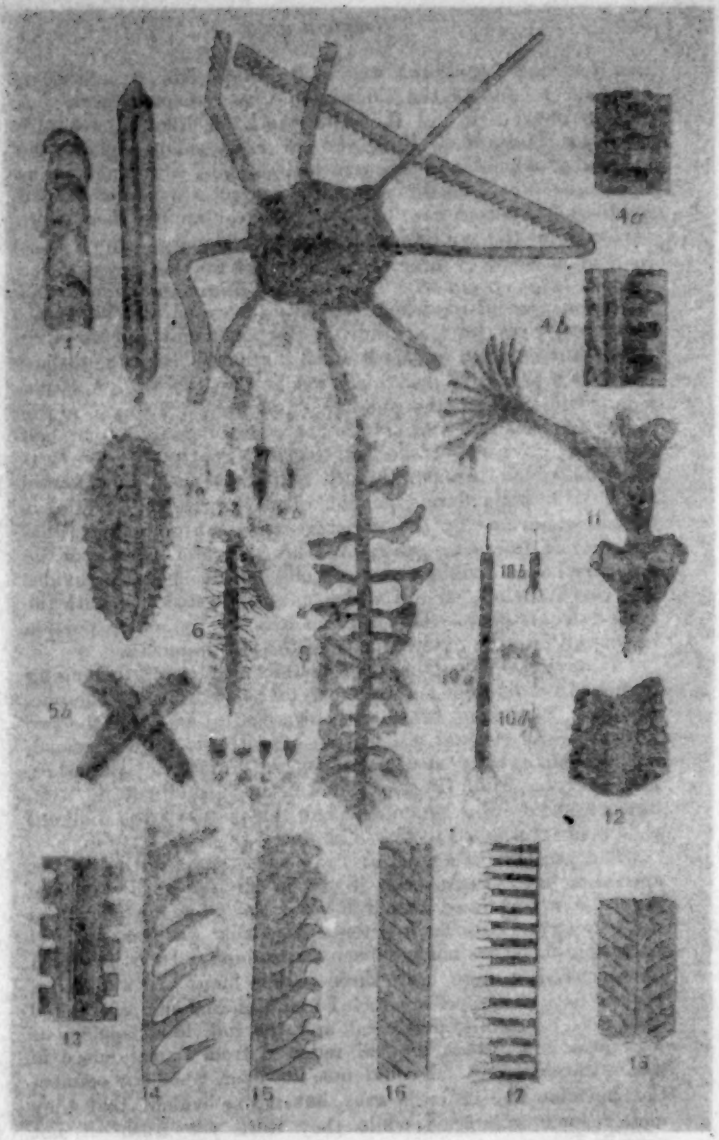
The double graptolite, for which M'Coy proposed the name *Diplograpsus*, appears to differ little, if at all, from the structure of the single forms. We shall have a correct impression of *D. pristis*, His. (Fig. 18), if we consider it as composed of two specimens of *G. Roemeri*, united back to back, having similar hydrothecæ, but with the posterior portions of the single polyparies removed, which, if present, would separate the animals of the two series, and the solid axis remaining in the centre of the common fleshy basis of the colony. Richter

describes and figures the axis in *D. folium*, His., as lateral, or attached to one of the sides, while the cœnosarc was continuous between it and the other side. A different structure has been observed by Hall, who has proposed to separate the species of which it is a characteristic into a distinct genus *Climacograptus*. In this group the polypites were not lodged in distinct hydrothecæ, but the cells containing them were enclosed in the continuous chitinous polypary, which was pierced at regular intervals by openings for the egress of the animals (Figs. 4 and 13). The axis is filiform and central, and the triangular plate, which partially separated the adjoining polypites, rises from a point in the axis, and widens as it passes upwards and outwards, until it reaches the outer surface of the polypary. A free space would thus be left on either side of the axis for the common cœnosarc. This axis, in the double graptolites, appears to have been double—one half belonging to each of the two series of polypites—for it is sometimes seen to separate into two divisions after it passes beyond the polypiferous portion of the organism, and this is further confirmed by the structure of a sub-genus (*Dicranograptus*) of *Climacograptus*. In this the older portion of the polypary has a double series of cells, but it speedily divides into two branches, each of which agrees in structure with the genus *Graptolithus*. The internal axis of the older portion breaks up into the external axes of the two branches.

Two remarkable genera of double graptolites, belonging perhaps to a different family, must be noticed here. The one, *Retiolites*, Barr. (Fig. 12), is without a central axis, and the two series of cells rise on either side of a single internal canal, which occupies the central portion of the polypary. The other, *Phyllograptus*, Hall (Figs. 5 *a* and *b*) has a solid central axis, but is destitute of a common canal, the plates of the different cells being continued to the solid axis.

The presence of a solid axis in all true graptolites deserves special notice. In several, if not in all the species of the family, it is continued naked beyond the growing portion of the polypary. How far it extended, or what was the nature of its termination, has not yet been ascertained. In *D. pristis*, I have noticed it more than three inches long. In a mass of specimens of this species, which I found on one slab, the naked axes were beautifully preserved, and the individual specimens were arranged so that they all radiated from a small space in which the axes met. I could not, however, trace any connection between the different axes, but it was evident that they had become entangled while they were yet fresh—if not actually living.

The appearance on this slab did not in the least correspond



STRUCTURE OF GRAPTOLITES.

to the aspect of Hall's remarkable genus, which he has named *Retiograptus*, in which the connecting axis is prolonged from the older portion of the organism. But the discovery of this form by Hall suggested the possibility of the supposed perfect specimens of *Diplograpsus* being only fragments of more complex forms, and on laying this slab open my first impression was that I had discovered such a perfect polypary. A connection by means of the growing axis would be somewhat anomalous, unless we supposed that the growth of the graptolite was like that of those oceanic hydrozoa whose hydrosoma consists of several polypites connected by a flexible filiform cœnosarc, which grows at its newer portion, or where it is attached to the swimming bell. But that this could not have been the method of growth is shown by the branching and rebranching form to which I gave the generic name of *Cladograpsus*, the ultimate divisions of the polypary of which has the axis produced beyond the growing polypiferous, and necessarily free portion. Neither could there have been any connection in *Diplograpsus* by the axis prolonged from the proximal end of the organism, for innumerable specimens show that it terminated at this end in one, two, or three spines or processes. In *D. scalaris*, His., the termination is simple; in *D. bicornis*, Hall, double; and in *D. tricornis*, Car., triple. The form and size of these processes can be distinctly seen, so that the organism must be considered complete at this the proximal end.

The openings of the hydrothecæ are, in some species, furnished with one or more processes (Fig. 17), in some short and firm, in others long and slender.

Form. The general form of the graptolite was, first, that of a slender, linear, indefinitely-produced polypary with a single series of cells, either simple (*Graptolithus*, L.), twice branched (*Didymograpsus*, M'Coy), symmetrically branched on either side of a primary point (*Tetragrapsus*, Salter, etc.), or repeatedly and irregularly branched (*Cladograpsus*, Car. not Gein.); or, second, a shorter and broader polypary with two series of cells (*Diplograpsus*, M'Coy), etc.

A more complex form has been found in America, which is considered by Hall as exhibiting the perfect polypary of the genus *Graptolithus*. The organism (Fig. 3) orignates in a short, barren process called the "radicle," which divides into two branches, which again divide more or less frequently, the portion of the polypary being without polypites until beyond the place of the final branching. The barren bases of the branches are united by a central disc composed of the same substance as the graptolite, and consisting of two layers, which, at least in the centre, are not united. Whether or not all the

American species of *Graptolithus* are fragments of this more complex form, I cannot say; but it is certain that few, if any, of our European species could belong to it. In many species, the termination of both extremities of the polypary is known, and that end by which they should be united to the compound group is certainly free. Salter was right in considering this compound form as the type of a different genus, to which he gave the name *Dichograpsus*.

There is no indication in any of the forms of a hydrorhiza, or of any means by which the polypary could have been attached to a foreign body. In the branching forms a slender initial process can generally be detected, to which Hall has given the name "radicle," but he does not consider this to have been a means of attachment, and it is not possible that it could have been so. We must consider that the graptolites possessed free polyparies.

Development. In 1858, I drew attention to young specimens of *D. tricornis*, and published a drawing of one; and in the following year Hall figured the young of apparently the same species. At the earliest stage these show all the characters of the adult. There is the solid axis continued above the polypary, and the three spines at the proximal end. Whether the "radical" in branching forms be the initial point in the development, it is evident, that the axis exists in the earliest state of *Diplograpsus*. At first a thin membrane is spread out between the spines and the slender axis at the distal end (Fig. 10 *d*). Next, there appear distinct indications of the hydrothecæ (Fig. 10 *b* and *c*); and these increase in number until the organism attains considerable size (Fig. 10 *a*). I have traced the history of *D. pristis* from a very young form like what has been by Mr. Nicholson, in the current volume of the *Geological Magazine*. At first they appear as triangular bodies, with the axis developed at both extremities (Fig. 7 *a* and *b*). The apex is the proximal end, and at the base the cells are developed (Fig. 8 *a* and *b*). In *Didymograpsus* I have observed specimens in which Hall's "radicle," with a single cell on either side has formed the whole polypary.

The origin of these minute forms has not been clearly traced. Hall figures a species of *Diplograpsus*, bearing what he believes to be reproductive sacs. This figure is reproduced on our plate (Fig. 8). Nothing like this has yet been found in Europe, but I have found several specimens of *D. pristis*, showing a series of interlacing fibres rising from the hydrothecæ (Fig. 6), similar to what Hall figures as the marginal fibre by which the reproductive sacs were attached to the axis of the graptolite, but from which the sacs themselves had been removed by maceration. He figures in connection with these

sacs a young specimen just beyond the margin and barely separated from the fibres of the sac (Fig. 8), and another below the sac. It has been recently supposed that numerous pedicellate bodies (Fig. 9) found in the graptolitic shales of Dumfriesshire are ovigerous vesicles, but as yet no case has been observed in which a relationship could be certainly traced between the fossil and the graptolites, and consequently the true nature of these bodies is very doubtful.

The first developed hydrothecæ are generally smaller than those formed later, making the outline of the polypary taper towards the older portion. In the genus *Graptolithus*, the earlier cells are sometimes more slender, and more separate from each other than they are afterwards. When the perfect size and form is attained, the additional hydrothecæ are exact repetitions of each other, and the polypary is parallel sided. In a few cases the newer as well as the older cells are small, as in *Phyllograptus* (Fig. 5 *a*) and in *D. folium*, His., in which the depth of the cells is increased by layers added to the mouth.

EXPLANATION OF PLATE.

Fig. 1. *Graptolithus priodon.* View showing the mouths of the hydrothecæ.

Fig. 2. Back view of ditto, showing the slender, solid axis.

Fig. 3. The disc and portion of the branches of *Dichograpsus.*

Fig. 4. *Climacograptus scalaris.* *a*, showing the cell openings in front; *b*, showing a portion of the second series of openings.

Fig. 13. Showing both series, preserved at right angles to that shown at Fig. 4.

Fig. 5. *Phyllograptus ilicifolius.* *b*, ideal section, showing the four series of cells. From Hall.

Fig. 6. *Diplograpsus pristis.* Specimen from which the reproductive sacs are supposed to have been removed (by maceration), leaving the marginal fibres by which they were attached.

Fig. 7. Young state of the same species.

Fig. 8. *Diplograpsus*, figured by Hall.

Fig. 9. Pedicellate bodies referred to in text.

Fig. 10. *Diplograpsus tricornis*, showing different stages in its growth between its adult condition, 10 *a*, and its youngest state, 10 *d*.

Fig. 11. Four cells and a polypite of the recent Sertularian, *Dynamena pumila.*

Fig. 12. *Retiolites Geinitzianus.* A fragment magnified.

Fig. 14. *Graptolithus convolutus.* ditto.

Fig. 15. *Graptolithus priodon.* Section magnified.
Fig. 16. *Graptolithus Roemeri.* ditto.
Fig. 17. *Rastrites*, sp. Fragment magnified.
Fig. 18. *Diplograpsus pristis.* Section magnified.

(To be concluded in an early number.)

A WHITE CLOUD ILLUMINATION FOR LOW POWERS.

BY HENRY J. SLACK, F.S.A., HON. SEC. R.M.S.

Microscopists have long adopted various modes of obtaining what is technically known as a "white cloud illumination," or illumination resembling that of solar light reflected from a white cloud. Some years ago a favourite plan was the employment of a disc of plaster of Paris in the place of the flat mirror; but such discs soon get dirty, and are therefore inconvenient. The white porcelain glass shades of lamps, like Mr. Pillischer's, enable an effect of this kind to be obtained, by so arranging a bull's-eye condenser, or stage mirror, that no direct light from the lamp-flame reaches the object, but only such rays as have previously suffered reflection from the porcelanous surface.

Another method employed with advantage, and recommended many years ago by the writer, was to take a disc of white foreign post paper, place it on a stouter paper, cover it with a few little bits of spermaceti and hold it over a lamp till the thin paper was thoroughly saturated with the molten matter. Such a piece of paper can be inserted in the frame carrying a bull's-eye, next its flat surface, or may be placed in the diaphragm hole under the stage. A still better plan for all but very low powers is to cut a small square or disk of the thin paper about seven-eighths of an inch in diameter, place it on an ordinary slide, in the middle, saturate it with spermaceti, and while the latter is hot place over it a thin covering glass, of a trifle larger size. This keeps the spermaceti always clean. The way to use it is to place the spermaceti slide on the stage, and the slide, carrying the object to be viewed, upon it. This gives a very pleasing illumination, and answers for all powers sufficiently high not to focus through the object-slide and show the surface of the spermaceti paper below it.

When using a binocular instrument, with powers of 1½ to 3 inches, ordinary methods fail to produce the soft, luminous, and opaque-looking background which is best fitted for large

transparent objects, and which ought to be as uniform as possible in brilliance throughout its whole extent. A single piece of ground glass gave upon trial an imperfect result, and the writer then went to Mr. Browning's factory, and selected a double concave lens, such as is used in telescope manufacture, about 1¼ inches in diameter. On one side this lens was ground with emery, and the other polished as usual. A flat disc of plate glass of the same size was also ground on one surface, and placed upon the lens so that the two ground surfaces were in contact. Mr. Browning then, by the writer's direction, cemented the two glasses by their edges, and mounted them in a brass cell fitting the substage apparatus of the microscope.

Nothing could be better than the effect thus obtained. Objects, such as insects mounted whole, the head and antennæ of the plumed gnat, delicate, transparent, anatomical preparations, came out beautifully with the binocular and powers of 1½ to 3 inches. The extreme softness of the light was commended by several experienced observers, and persons with sensitive eyes declared that they could view the objects steadily without fatigue.

It was obvious that by grinding one surface of the lens, its action as a lens must be greatly interfered with, but the experiment was made in the belief that it would still exert a more dispersive action than a flat piece of glass. To test this, Mr. Browning was asked to grind two flat discs of plate glass on one side only, and they were found to perform so nearly as well as the combination of flat disc and lens, that the writer is disposed to recommend them instead, as they are cheaper. Comparative experiments seemed to show a slight superiority in the lens combination, which is certainly less pervious to light. When one disc of ground glass only was tried, the effect was far less satisfactory than with the two.

These discs should be cemented together while their ground surfaces are fresh. All dust is thus excluded, and the permanent whiteness of the field ensured. Different kinds of glass grind with different degrees of whiteness, and that which gives the most snowy-looking surface should be selected.

Almost every microscopist has doubtless used ground glass for this purpose; but those who try two ground surfaces instead of one, and adopt the method here pointed out for keeping them clean, cannot fail to be pleased with the result.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1867. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 3·30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Jan. 1	29·369	28·3	24·2	·86	·174	31·6	24·3	7·3	2, 2, 2	NNW, N, W by N.	0·000
„ 2	29·177	26·4	...	...	·163	28·7	19·9	8·8	10, 7, 5	NNE, N, N by W.	1·167†
„ 3	29·788	24·2	...	...	·150	28·6	5·7	22·9	10, 10, 10	SW, N by E, NW.	—
„ 4	29·981	10·7	...	...	·092	21·6	5·0	16·6	10, 5, 10	SW, —, NW by N.	—
„ 5	29·965	26·5	...	...	·164	30·8	1·0	29·8	10, 10, 10	E, E, ESE.	—
„ 6	...	...	...	...	...	48·7	21·1	27·6	...	...	—
„ 7	29·138	50·5	48·2	·92	·380	54·7	32·3	22·4	10, 9, 8	S, SW, SSW.	·750‡
„ 8	28·936	46·2	40·8	·83	·328	52·6	48·3	4·3	10, 8, 2	SW by W, WSW, SW by W.	·220
„ 9	28·923	44·3	40·2	·87	·307	47·8	39·7	8·1	10, 10, 10	S by W, SW, SSW.	·000
„ 10	29·266	39·0	32·3	·79	·255	41·2	39·6	1·6	4, 9, 10	NNW, NW, NW.	·270
„ 11	29·672	32·4	26·5	·81	·202	36·3	31·2	5·1	4, 3, 0	NNE, NNW, NNW.	·000
„ 12	29·591	29·6	26·4	·89	·183	32·3	22·4	9·9	7, 10, —	SSW, W, WNW.	·000
„ 13	...	...	...	...	...	29·2	17·5	11·7	...	...	·080†
„ 14	29·875	22·0	...	...	·139	29·8	10·5	19·3	0, 0, 0	SW, NW by W, —.	·000
„ 15	29·913	27·0	...	...	·167	31·3	14·3	17·0	0, 1, 5	N, N, NW by N.	·000
„ 16	29·759	30·9	25·5	·83	·191	34·7	24·1	10·6	5, 10, 10	N, NNE, N.	·000
„ 17	29·509	26·8	...	...	·165	29·8	27·9	1·9	7, 7, 2	NW by N, N, NW.	·000
„ 18	29·545	28·0	...	...	·173	31·1	23·3	7·8	10, 7, 10	W by N, NW, N by E.	·000
„ 19	29·863	26·0	...	...	·160	32·0	21·2	10·8	5, —, —	SW, —, —.	·017†
„ 20	...	...	...	...	...	31·1	21·8	9·3	...	...	·000
„ 21	29·858	27·7	20·4	·77	·171	29·3	28·0	1·3	10, 9, 10	E by N, E by N, E by N.	·000
„ 22	30·014	25·0	22·7	·92	·155	26·6	23·0	3·6	10, 10, 10	SE, ESE, E by S.	·000
„ 23	29·692	46·4	46·2	·99	·330	49·9	21·0	28·9	10, 10, 10	S by W, SW by S, S by W.	·090
„ 24	29·471	50·6	48·2	·92	·381	54·8	45·5	9·3	10, 9, 8	SW, SW by W, SW.	·009
„ 25	29·602	44·5	38·1	·80	·309	49·8	38·1	11·7	10, 8, 3	W by S, W by N, W by N.	·020
„ 26	29·984	41·0	37·8	·89	·273	54·2	39·0	15·2	10, 10, 10	WSW, S by E, S by E.	·000
„ 27	...	...	...	...	...	56·4	40·7	15·7	...	...	·260
„ 28	29·848	50·0	46·0	·87	·373	52·8	49·3	3·5	10, 10, 3	SW, SW, W by S.	·006
„ 29	29·939	46·6	43·3	·89	·332	52·2	39·4	12·8	3, 10, 10	S by W, SW, SW.	·000
„ 30	29·686	48·1	45·4	·91	·350	51·8	44·5	7·3	7, 10, 10	SW by W, SW, SW by S.	·080
„ 31	30·173	42·2	33·1	·73	·285	46·9	37·8	9·1	1, 5, 10	W by N, W by N, SSW.	·404
„											
Daily Means.	29·649	34·8	(35·8)	(·86)	·235	...	...	12·0	...	...	3·373

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

† Equivalent of snow in rain.

‡ Melted snow and rain.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JANUARY, 1867.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12		5	5	1	1	0	30	16	40	13	23	7	8	10	3	7	15	19	5	4	17	29	18	10	18	2	19	19	17	7	22	14	13·0
1	A.M.	10	6	1	2	1	32	17	38	15	25	9	8	10	1	3	15	20	4	3	23	24	14	9	19	4	15	18	14	8	22	18	13·2
2		13	12	1	3	0	35	18	39	17	20	7	7	10	2	3	17	21	6	4	23	24	10	10	19	3	10	18	15	7	24	11	13·2
3		11	16	1	2	1	20	18	43	15	19	8	7	8	2	9	17	19	5	5	29	28	13	6	20	3	10	19	15	13	24	15	13·6
4		17	16	2	1	1	17	20	53	17	23	8	6	6	1	13	16	19	6	3	25	30	14	4	30	3	6	15	18	12	22	14	14·1
5		11	22	0	1	1	18	17	33	19	19	8	3	9	1	10	19	18	5	4	26	29	10	12	26	1	8	15	19	14	15	15	13·2
6		13	35	3	1	1	16	18	40	17	17	10	5	10	1	8	21	17	4	1	31	31	11	9	19	2	5	15	18	12	16	12	13·5
7		15	24	2	3	3	19	19	35	20	17	13	8	6	0	9	21	16	5	1	32	35	10	7	16	4	4	22	19	15	18	10	13·8
8		13	33	3	1	7	13	21	31	23	17	12	7	9	0	7	22	14	5	2	30	37	10	10	18	4	5	16	19	19	11	8	13·8
9		12	29	3	1	8	12	22	38	20	18	12	9	7	1	7	17	13	5	1	29	36	10	9	19	8	5	17	21	20	14	11	14·0
10		14	30	3	2	9	8	22	23	22	16	17	13	10	3	6	23	15	6	5	39	32	8	13	18	7	4	17	21	18	18	15	14·5
11		13	27	2	1	8	7	28	30	20	17	16	17	11	4	7	23	17	6	2	37	31	13	14	20	13	4	17	21	21	18	25	15·8
12		11	26	2	2	6	6	25	26	23	19	15	13	10	3	11	27	19	4	8	34	32	12	15	23	13	7	19	22	23	16	22	15·9
1	P.M.	10	24	2	2	13	5	23	21	28	16	15	13	11	3	11	25	17	5	4	35	30	10	11	17	17	6	15	21	24	16	19	15·1
2		7	23	3	0	17	5	19	24	32	16	11	11	10	8	10	25	14	5	10	31	28	10	9	19	14	6	13	18	21	8	16	14·0
3		6	16	3	0	19	2	21	19	32	14	14	16	5	4	8	21	13	6	10	30	24	11	11	16	18	7	10	19	19	13	13	13·5
4		4	15	3	2	22	4	20	16	28	15	9	14	4	5	10	19	12	5	9	36	30	10	11	12	16	10	11	16	21	19	6	13·3
5		6	7	3	1	23	1	24	14	22	13	10	13	3	2	11	18	14	6	7	34	24	12	13	10	9	13	11	23	23	29	6	13·1
6		4	9	5	0	26	2	27	18	26	10	9	12	2	3	15	18	10	7	12	37	26	11	19	12	15	17	13	17	23	31	4	14·2
7		2	6	4	0	28	2	25	14	20	8	9	16	5	4	13	16	8	7	18	38	25	16	17	4	14	17	11	18	23	29	7	13·7
8		4	5	3	1	26	10	27	14	22	10	10	7	2	3	14	16	8	5	13	40	19	17	20	6	16	19	13	16	22	23	9	13·5
9		3	3	4	0	25	10	27	13	23	9	10	7	5	5	16	18	5	5	14	33	17	13	15	5	16	25	11	11	24	18	6	12·8
10		3	3	2	1	29	13	34	14	25	10	9	10	5	5	16	19	9	6	10	38	20	13	21	5	18	20	15	9	25	15	11	14·0
11		5	2	3	0	25	14	38	17	21	8	11	10	3	2	13	17	6	7	14	35	24	11	17	4	17	18	16	12	21	12	9	13·3
12																																	
Total Daily Movement.		212	394	59	28	299	301	546	653	520	379	259	240	171	66	237	465	343	130	164	753	665	287	292	375	237	260	366	419	435	453	296	13·8

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		Rain—read at 10 A.M.
	Barometer corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Feb. 1	30·099	46·6	46·0	·98	·332	50·0	...	...	10, 10, 10	SW, SW, SW by S.	0·000
„ 2	30·054	45·1	33·7	·67	·315	49·2	43·9	5·3	0, 5, 4	WSW, W, W by N.	·000
„ 3	...	...	...	...	...	46·4	32·0	14·4	...	...	·000
„ 4	29·538	43·5	41·9	·94	·298	49·4	36·2	13·2	10, 10, 6	SSW, SW, W by S.	·010
„ 5	29·280	42·9	41·2	·94	·292	54·1	35·2	18·9	9, 10, 10	SSW, S by W, SW.	·101
„ 6	28·911	43·2	37·6	·83	·295	49·8	41·1	8·7	8, 5, 3	W, W, W by S.	·174
„ 7	29·664	40·5	27·3	·63	·269	52·6	36·0	16·6	0, 5, 10	W by N, W, SW by W.	·005
„ 8	29·387	49·8	45·1	·85	·371	54·7	39·6	15·1	10, 10, 8	W, SW by W, WSW.	·190
„ 9	29·948	47·2	39·1	·76	·339	52·6	43·5	9·1	0, 6, 10	W, WSW, SW.	·025
„ 10	...	...	...	...	...	51·8	45·0	6·8	...	...	·055
„ 11	30·124	42·1	32·2	·71	·284	46·5	40·1	6·4	0, 9, 8	WNW, W, WSW.	·234
„ 12	30·245	48·2	45·0	·89	·351	50·9	40·6	10·3	10, 10, 10	W by S, WNW, W by N.	·000
„ 13	30·357	46·1	43·7	·92	·326	49·5	44·6	4·9	10, 10, 10	WSW, W by S, SW by W.	·004
„ 14	30·291	46·7	41·1	·82	·333	50·4	45·1	5·3	10, 7, 0	E, E by N, ENE.	·000
„ 15	29·890	48·8	39·9	·73	·358	54·8	41·2	13·6	2, 8, 10	E by N, SSE, S by W.	·000
„ 16	29·790	49·8	46·4	·89	·371	55·8	44·4	11·4	9, 5, 7	S by E, SSW, S.	·090
„ 17	...	...	...	...	...	55·8	44·1	11·7	...	...	·331
„ 18	30·433	41·9	42·3	1·00	·282	46·2	41·1	5·1	10, 10, 10	E by S, E by S, SE by E.	·000
„ 19	30·342	46·2	43·9	·92	·328	51·1	40·1	11·0	10, 10, 10	SE by E, SE by S, SSE.	·000
„ 20	30·476	49·7	43·6	·81	·369	54·8	44·3	10·5	10, 2, 2	SSW, W, SW by W.	·000
„ 21	30·515	47·6	43·9	·88	·344	51·6	41·0	10·6	10, 10, 10	SW, WSW, SW by S.	·000
„ 22	30·427	46·8	43·6	·90	·334	50·8	46·0	4·8	10, 10, 10	SSW, WSW, WSW.	·000
„ 23	30·481	47·4	37·3	·70	·341	52·4	41·9	10·5	7, 2, 6	NW by N, NW by N, W by N.	·000
„ 24	...	...	...	...	...	52·7	37·1	15·6	...	...	·001
„ 25	30·160	44·5	35·1	·72	·309	49·8	37·1	12·7	7, 9, 3	W, W, W by S.	·000
„ 26	30·010	39·0	36·0	·90	·255	41·5	40·5	1·0	10, 10, 10	N, WNW, W.	·013
„ 27	30·067	37·1	26·0	·67	·239	40.7	36·8	3·9	10, 10, 10	E, E by N, E by S.	·020
„ 28	30·236	38·0	28·0	·70	·246	42·9	34·1	8·8	9, 6, 7	E, NE, NE.	·000
Daily Means.	30·030	44·9	39·2	·82	·316	...	...	9·9	...	...	1·253

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—FEB., 1867.

Hour.	Day. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
12	10	15	8	16	13	24	16	28	27	12	27	16	7	6	11	17	1	2	5	3		10	14	7	11	25	2	6	12·5
A.M. 1	13	17	5	13	14	23	17	18	26	14	19	16	4	7	14	14	2	2	5	3		11	13	7	9	25	2	8	11·9
2	15	15	9	16	12	30	13	18	24	16	8	14	4	10	18	16	1	4	8	4	150	6	9	8	6	20	0	9	11·6
3	15	15	6	18	11	42	14	17	19	16	9	15	5	7	19	18	1	4	5	5		5	7	7	9	20	2	7	11·8
4	16	16	9	19	11	33	10	18	21	18	5	15	7	9	14	14	1	4	3	5		5	5	8	10	19	4	9	11·4
5	15	13	5	17	13	24	10	25	20	20	9	11	5	7	13	13	1	6	5	3		5	7	11	7	16	9	10	11·1
6	15	13	5	18	15	23	11	24	21	22	14	11	6	8	18	15	3	4	7	4		10	6	15	11	15	6	13	12·3
7	15	10	9	19	14	27	14	26	14	18	16	12	5	9	18	15	2	4	5	7		13	9	12	9	9	13	10	12·4
8	12	8	5	21	16	22	20	27	10	17	20	11	5	11	15	14	2	8	5	8		12	8	18	9	7	11	12	12·3
9	9	12	7	22	18	32	22	22	11	15	18	13	4	15	20	13	3	5	4	3		12	8	12	14	10	15	11	13·0
10	11	18	8	27	18	33	23	27	13	20	22	9	4	15	13	15	2	5	8	4	12	14	15	21	16	8	14	13	14·6
11	11	19	10	27	20	34	27	26	16	21	25	14	3	15	13	15	3	10	9	6	12	14	16	21	17	9	15	14	15·8
12	11	21	10	26	20	31	31	14	21	24	15	3	12	14	15	2	10	9	10	13	15	16	20	14	8	13	15	15·8	
P.M. 1	13	21	13	25	24	34	29	28	11	20	22	13	2	17	15	15	3	10	8	11	10	16	13	24	13	6	15	11	15·8
2	14	18	10	23	21	27	29	26	9	20	23	11	4	16	17	10	4	8	9	11	15	16	12	19	12	2	12	19	14·9
3	14	16	7	21	15	33	20	24	7	25	26	11	1	17	15	9	1	7	9			13	17	8	23	12	9	17	16	14·5
4	17	10	9	16	12	32	14	21	9	26	15	11	3	15	21	10	1	9	7			13	14	6	18	12	5	11	13	13·0
5	15	9	9	12	13	24	11	21	7	22	10	14	2	11	14	8	3	6	6			7	13	5	18	12	5	9	11	11·0
6	17	8	10	17	16	24	12	21	5	20	23	5	2	10	17	6	1	6	3			9	14	2	18	13	3	7	7	11·0
7	18	9	9	17	14	25	14	22	8	25	12	5	3	10	21	1	1	9	5			9	14	3	18	17	3	7	8	11·4
8	17	8	8	12	13	24	13	20	5	24	12	6	3	5	18	6	1	10	8			15	14	4	16	16	4	5	10	11·0
9	17	7	11	10	25	24	17	18	7	30	13	7	3	7	17	3	1	10	5			12	13	4	13	21	3	5	7	11·5
10	17	7	14	14	25	22	21	22	9	30	15	7	5	11	23	1	2	9	3			8	12	5	8	21	5	10	8	12·4
11	18	7	18	11	24	20	24	23	10	26	14	6	6	7	19	1	2	3	2			8	11	5	10	22	3	7	9	11·7
12																													
Total Daily Movement.	345	312	214	437	397	667	432	553	323	498	401	268	96	257	397	264	44	155	143		390	286	200	352	313	239	211	256	12·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		Rain—read at 10 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Mar. 1	30·558	35·3	27·4	·75	·224	40·6	28·5	12·1	7, 10, 8	N, NE, N.	0·000
„ 2	30·727	32·4	22·8	·71	·202	37·8	31·4	6·4	10, 4, 9	NE, NE, E by N.	·000
„ 3	...	...	...	...	...	41·7	29·1	12·6	9, 0,	... ...	·000
„ 4	30·403	39·0	31·1	·76	·255	45·1	34·5	10·6	9, 1, 3	NE, NE by E, NE.	·033
„ 5	30·077	40·4	33·6	·79	·268	46·9	34·6	12·3	10, 3, 5	NNE, NE by E, NNE.	·004
„ 6	29·749	33·8	29·5	·86	·212	39·6	33·3	6·3	10, 10, 8	N by E, E by S, E.	·000
„ 7	29·621	31·8	29·3	·91	·198	36·7	30·5	6·2	10, 5, 8	E by N, NE, NE.	·040†
„ 8	29·525	32·8	27·3	·82	·205	38·1	30·6	7·5	10, 9, 7	NE, ENE, ENE.	·027
„ 9	29·465	34·1	29·8	·86	·215	40·2	30·5	9·7	10, 10, 10	NE, E by N, —.	·000
„ 10	...	...	...	...	...	43·8	34·1	9·7	...	... ...	·429
„ 11	29·663	34·8	31·4	·88	·220	38·8	35·0	3·8	10, 10, 10	NE by N, NE, E by N.	·024
„ 12	29·778	32·1	28·5	·88	·200	37·7	31·5	6·2	10, 10, 10	NE, by E, E, E by N.	·144†
„ 13	29·839	28·5	24·9	·88	·176	33·8	4·0	29·8	10, 10, 10	ENE, E, E.	·004
„ 14	29·540	30·7	31·2	1·00	·190	35·2	28·7	6·5	10, 10, 10	NE by E, NNE, NE by W.	·430†
„ 15	29·753	33·5	27·7	·81	·210	38·7	30·6	8·1	10, 8, 7	NE by N, NNE, N by E.	·096†
„ 16	29·941	33·4	23·7	·71	·209	40·5	25·0	15·5	5, 5, 2	NW by N, NE, NE by N.	·000
„ 17	...	...	...	...	...	36·9	27·3	9·6	...	... ...	·000
„ 18	29·494	28·9	...	...	·178	32·7	11·5	21·2	10, 10, 10	E, E, E by S.	·000
„ 19	29·313	32·1	32·4	1·00	·200	36·0	30·3	5·7	10, 10, 10	E by N, ENE, NE.	·050†
„ 20	29·539	33·7	29·3	·86	·212	38·7	33·0	5·7	10, 10, 9	NNE, N by E, N.	·164†
„ 21	29·845	33·9	26·3	·76	·213	39·7	29·5	10·2	4, 10, 10	NE by E, ESE, E.	·000
„ 22	29·680	36·7	36·4	·99	·235	43·3	30·4	12·9	10, 10, 10	E by S, W by S, SW by S.	·270†
„ 23	29·640	47·5	46·1	·95	·343	54·4	34·6	19·8	10, 10, 9	SE, S, SSE.	·000
„ 24	...	...	...	...	...	56·3	45·9	10·4	...	... ...	·062
„ 25	29·625	46·8	45·8	·97	·334	53·1	45·3	7·8	10, 10, 10	SW, SE by S, S by W.	·000
„ 26	29·379	50·0	41·2	·74	·373	55·9	47·3	8·6	5, 4, 4	SW by S, NW, NW.	·100
„ 27	29·312	47·3	41·7	·82	·340	54·3	42·4	11·9	10, 10, 7	SW, SSW, SW.	·000
„ 28	29·412	44·9	32·8	·66	·313	51·8	34·3	17·5	3, 6, 2	W by N, SW, WNW.	·023
„ 29	29·623	44·7	32·4	·65	·311	50·3	34·8	15·5	5, 8, 10	W by N, WNW, W by N.	·000
„ 30	29·729	44·7	36·9	·76	·311	52·5	35·8	16·7	4, 7, 9	W, W by S, WSW.	·000
„ 31	...	...	...	...	...	47·9	36·2	11·7	...	... ...	·080
Daily Means.	29·740	37·0	32·0	·83	·244	...	...	11·2	...	... ...	1·980

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Melted snow and rain.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—March, 1867.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12		9	9	16	19	14	9	15	7	10	30	8	10	34	30	7	3	8	35	10	11	9	20	4	12	17	17	15	6	7	6	23	13·2
A.M. 1		7	10	15	17	11	6	14	10	8	34	8	11	29	29	4	2	10	37	11	12	8	22	3	9	17	19	13	7	9	7	25	13·7
2		4	11	15	16	19	7	16	10	6	33	5	13	29	22	6	3	10	36	16	12	10	22	5	6	15	25	11	6	6	8	24	13·8
3		5	11	15	13	16	8	16	7	7	33	4	12	31	23	7	3	8	32	14	10	7	23	5	8	15	29	9	6	8	10	20	13·4
4		5	9	20	10	18	4	14	8	7	32	6	16	32	19	8	3	11	35	10	10	9	20	6	9	16	26	9	6	7	10	18	13·0
5		5	6	17	11	21	2	15	10	7	24	6	16	30	18	12	2	10	34	15	10	9	19	8	6	11	25	11	5	8	7	15	12·7
6		4	9	18	21	21	10	11	9	6	19	6	17	29	21	9	2	10	34	14	10	7	17	6	4	14	30	12	6	7	10	17	13·2
7		1	8	21	22	19	11	10	9	5	16	9	19	34	19	9	4	9	35	16	10	7	16	13	4	12	32	15	7	5	7	21	13·7
8		6	12	22	24	16	16	10	11	9	14	10	16	33	21	8	7	11	31	19	13	9	14	10	8	17	35	18	8	9	14	20	15·2
9		10	13	22	18	20	17	12	8	8	14	9	14	33	21	10	10	16	28	22	13	13	15	10	12	17	31	18	10	11	19	19	15·9
10		15	22	23	27	21	20	13	14	11	13	12	18	34	21	14	12	23	27	21	12	16	10	12	13	19	32	17	11	14	17	21	17·9
11		15	23	29	25	21	22	19	16	16	14	11	24	35	20	18	13	24	33	20	17	17	6	20	15	17	31	16	14	13	16	19	19·3
12		13	24	29	21	11	23	16	11	16	13	10	28	34	17	15	18	25	27	22	14	17	5	24	15	17	31	17	12	13	20	18	18·6
P.M. 1		13	22	26	24	18	21	14	11	20	13	6	27	33	16	16	20	25	20	14	16	18	3	26	12	17	32	13	11	12	24	15	18·0
2		10	24	27	24	17	25	15	13	22	15	8	36	31	15	13	14	26	19	18	16	19	9	21	17	21	31	9	15	15	25	15	18·9
3		9	21	22	21	19	16	16	15	25	15	9	36	31	14	15	22	29	17	15	16	20	5	20	19	22	33	14	16	13	26	13	18·8
4		8	20	20	21	17	15	18	17	27	16	7	44	34	16	12	20	28	14	14	15	24	2	20	21	23	28	15	13	15	20	11	18·5
5		7	16	16	20	12	12	13	14	29	17	8	35	28	15	12	18	27	11	13	13	18	2	27	15	14	25	12	10	12	18	11	16·1
6		11	15	19	17	11	18	10	11	29	12	10	38	26	16	7	17	27	12	13	13	19	4	26	15	25	22	8	14	10	16	8	16·1
7		10	11	22	18	12	18	10	11	30	10	12	32	26	18	5	14	28	11	13	11	15	4	24	14	17	18	6	11	11	15	5	14·9
8		11	12	17	10	15	15	7	10	33	9	13	28	26	15	3	10	32	10	12	11	16	3	22	15	19	15	4	10	11	15	8	14·0
9		12	16	17	12	11	16	6	10	33	10	15	33	29	10	7	8	32	10	13	9	18	4	19	22	16	12	5	6	9	11	1	14·0
10		10	15	20	14	7	17	9	10	32	11	11	39	30	10	8	7	37	9	13	9	17	3	17	24	20	14	5	7	12	19	4	14·8
11		8	14	19	14	5	13	10	9	30	9	10	30	30	9	4	9	35	6	11	4	16	3	10	20	18	15	6	6	7	18	3	13·1
12																																	
Total Daily Movement.		208	353	487	439	372	341	309	261	426	426	213	592	741	435	229	241	501	563	359	292	338	251	358	315	416	608	278	223	246	358	351	15·4

BIOGRAPHY OF SWEDENBORG.*

A NEW life of Swedenborg, with an account of his writings, in two bulky volumes, might seem a somewhat perilous experiment upon the taste of the public, and still more so when, as is the case with Mr. White's labours, they can scarcely expect to be accepted as representing the views of the small though energetic sect of which the celebrated Swede is the apostle and prophet. As is the case with nearly all the biographical works that are produced in these days, the present one has the faults of diffusiveness and prolixity. It is written from a point of view remote from that of philosophical criticism, and, in many passages, almost equally so from that of faith in the pretensions of its subject. Mr. White may, perhaps, object to the latter part of this remark, and it is only fair to cite his concluding words, in which he exclaims, "time only adds to the power and clear shining of my author's fame," and affirms that although his claim is "an awful one," "yet the more I study his writings, and learn to disregard their extraneous encumbrances, the more credible does the claim become."

The popular idea of Swedenborg is simply that of a clever man suffering from cerebral derangement, and taking the visions of a disordered imagination for a positive insight into the mysteries of the spirit-world. A little investigation into the personal character and proceedings of the mystic philosopher, as he is displayed in Mr. White's pages, will somewhat modify this idea. Those who accept Swedenborg's claims as prophet and seer, will, of course, deny that he laboured under chronic hallucination, or that cerebral derangement tinctured and characterized all his speculations. On the other hand, those who can see no reason for supposing the illustrious Swede to have been supernaturally endowed, or enlightened, will regard his case as worthy of careful study, upon psychological and medical grounds, and will be induced to place him amongst a class of persons who, in various ages of the world, have exercised great and often enduring influence over their fellow-men, and in whom the normal action of the intellectual powers was modified, though not entirely dominated, by delusion and disease. In many mystics a much greater excitation of the moral and emotional nature was manifested than Swedenborg displayed. In him, the rationalizing and philosophical element predominated all through, and his visions revealed nothing that was not in accordance with the general tenor of thought, proceeding logically from the facts which he was acquainted

* *Emanuel Swedenborg: his Life and Writings.* By William White. 2 vols. Simpkin, Marshall, and Co.

with, and the premises which he accepted. His method of reasoning was defective, but it was a *method*, and not a haphazard performance; and when, what most observers would consider his insanity was at its height, it seems to have left his thinking faculties clear, and to have misled him almost exclusively, by inducing him to mistake internal impressions for external facts.

Some peculiarities of Emanuel Swedenborg were derived from his father, concerning whom Mr. White gives many curious particulars, accompanied by a portrait, in which a strong tinge of insanity is apparent. Jesper Svedberg, the father of Emanuel, rose from humble origin to be bishop of Skura. His father's name was Isaksson, and the appellation Svedberg—which by royal orders became lengthened into Swedenborg, in Emanuel's honour—was derived from a piece of property which the family owned. Jesper Svedberg was a remarkably self-satisfied, self-contained man, with an inflexible obstinacy of purpose, and a determination to get on in the world. He believed that angels spoke with him and assisted his plans. Having attained to a respectable pecuniary position, he married a rich wife, and after spending six months with her, obtained permission to absent himself from his duties as Chaplain to the Life Guards of Charles XI., and employed nearly a year in visiting Germany, France, Holland, and England. On his return to Stockholm, he found his wife had presented him with his first son, and a few years later, on the 29th January, 1688, his second son, the future mystic, Emanuel, was born. Jesper Svedberg was always active, whether as simple clergyman or as bishop, and in the main must have been a useful man, though wanting in consideration for the thoughts and feelings of other folks.

Svedberg lost his first wife in 1696, and in the following year espoused a second. The lady upon whom his choice fell had been twice a widow, and he engaged himself to her without having seen her. He states that he was unexpectedly informed of her goodness, piety, excellent housekeeping, sufficiency of property, and absence of children. "What more could be desired?" the shrewd Jesper exclaims, in his narrative. "In a word, she seemed a woman who would suit me well. I wrote to her, and laid bare my thoughts, and she acceded to my request. Two days before my wedding, I went to Stockholm, whither she also, by agreement, repaired. I was put into a room where she was sitting alone; but I did not know, and never imagined it was she, for no man had told me. . . . At length she said, 'What do you think of our bargain, M. Professor?' I replied, 'What bargain do you refer to?' 'That which you have written about,' she said.

'I do not know what you mean,' I answered. 'Are we not,' she said, 'to be man and wife to-morrow?'" Hereupon Jesper Svedberg jumped up, shook hands, and gave a loving embrace to his wife elect!

Swedenborg's father was thus a strange character; hard-working, vigorous, self-seeking, yet duty-loving; quite sure that angels talked with him, and able, as he states, to exorcise devils, and turn them out of mind or body.

Further curious particulars concerning Jesper Svedberg will be found in Mr. White's book; but enough has been said to indicate some of the peculiarities which he transmitted to his son Emanuel.

In 1709, at the age of twenty-one, Emanuel took his degree as Doctor of Philosophy, at Upsala, and in the following year paid his first visit to London, and spent four years in England, Holland, and France. During this period, physical science and mechanical invention chiefly occupied his thoughts, and he designed a ship to float under water, a mode of lifting weights by means of a syphon, a mode of constructing sluices in places where there is no fall of water, by means of which large ships and their cargoes may be raised to any height within an hour or two, a flying chariot, and many other things, amongst which was "a method of discovering the desires and affections of the minds of men by analogies."

In 1716, Charles XII. appointed Swedenborg Extraordinary Assessor in the College of Mines, and also availed himself of his services as engineer. After the death of Charles XII. he continued his scientific pursuits, and complained bitterly of the neglect which useful novelties then experienced in Sweden. Methods of finding the longitude by means of the moon, observations and speculations in geology, propositions for reforming weights, measures, and currency, so as to facilitate calculation—these were among his studies; and as they brought him no employment, he again took to travelling, writing, and publishing. His revelations of trade secrets in mining and metallurgy being objected to, he replied, that "whatever is worth knowing should, by all means, be brought into the great and common market of the world. Unless this be done, we can neither grow wiser nor happier with time."

Attempting to trace how the physical frame of things began, he assumed motion to have originated in a *point*, which he defined as the simplest existence, and proceeding immediately from the Infinite. This point he described as pure and total motion. By a union or combination of "points," the first finite is derived, having two natural poles formed by the spiral motion of the points, and revolving on its axis. By further combinations he fancied other finites were composed, the

fourth being ether, and the fifth air, and "in a state of still closer compression, water." Water, he thought, according to the erroneous belief of the time, to have no elasticity, and, therefore, he did not regard it as belonging to the elemental kingdom. He says, "It is purely the first material finite. In a globule of water is contained all that had previously existed from the point downwards, like box within box." With these "points" as materials, it was easy to develope a cosmogony, and show how the sun and the planets were produced, and something like the nebulous theory seems to lurk in the expressions cited by Mr. White.

A fundamental doctrine of Swedenborg is that "matter is everywhere the same in great as in little." This he applied in all his cosmical and chemical speculations, and also made it the foundation of his theories concerning spiritual worlds, which he conceived to correspond in almost all their facts and conditions with the lower world of matter and mortal life.

Anatomy and physiology occupied much of Swedenborg's time, and he thought to find the soul in the finest and most subtle tissues of the body. The red blood he supposed to be divided into a purer blood, and a purest, which he called "spirituous fluid," and he described the blood as the most complex of all things, and asserted that it contained "salts of every kind, both fixed and volatile, and oils, spirits, and aqueous elements; in fine, whatever is created and produced by the three kingdoms of the world—the animal, the vegetable, and the mineral." He fancied red blood globules to be composed of white globules, aggregated in sixes round cubes of common salt, and inside the ultimate globules he placed the "animal spirits," imaginary entities generally believed in at that date. From common salt, by truncation of its angles, and various arrangements of its particles, he thought acids and alkalies were formed.

The animal spirits were in his philosophy the vesture or body of the soul, and the soul itself was "a fluid most absolute." Respiration he conceived to be a mode of feeding upon aerial food, in which the lungs sucked ether from the air, and converted it into white blood.

Looking to Swedenborg's scientific attainments, no one can doubt that he was a man of remarkable talent, knowledge, and ingenuity; but there is a wide difference between an inventive man, well stored with the current facts and processes of his day, and a great original thinker and observer in science. Those who claim the latter position for Swedenborg seem to us to exaggerate the merit of his lucky guesses, and to overlook his palpable blunders and absurdities. Although he professed the doctrine that experience was the basis of know-

ledge, he was continually unable to discriminate between what was actually ascertained by means of experience, and what was simply imagined by pursuing a theory to its ultimate results. Modern philosophers have completely given up the vain attempt to know what matter is in its essence. They content themselves with studying its actions and effects, and the doctrine is becoming prevalent that all forces are modes of motion of material particles, whatever such particles may be.

The supposition that mathematical relations of quantity prevail all through nature, from the smallest and subtlest, to the largest and most concrete forms, originated with the old Greek philosophers; and Swedenborg can lay no claim to originating such an idea. That he had glimpses of real laws and truths not recognized in his day, we may fairly concede, but his philosophy was a jumble, in which fact and fancy, rationality and delusion, were mixed.

He united, to a degree seldom witnessed, the opposite faculties of acquiring extensive and accurate knowledge in experimental and observational sciences, and of being under the influence of dreams and hallucinations, during the continuance of which scientific principles of verification were freely abandoned. His mind was remarkably inventive, and when not engaged in endeavouring to make new applications of physical science, he invented in the realms of social, psychological, and theological speculation. He stands alone amongst the mystics for extensive acquisition of positive knowledge, and for zeal in its diffusion. The oriental mystics lost sight of earth, in their imaginary contemplations of heaven—Swedenborg always had an eye to the practical, and his speculations were intended, and often did tend, to the improvement of mankind.

The place assigned to Swedenborg as a scientific man will vary with the notions of what constitutes discovery, which his critics or admirers entertain. Most important discoveries have been imperfectly shadowed forth in the sayings or statements of those who did not know how to give them a definite and enduring shape; and, perhaps, no clever man, in any age of the world, has ever speculated much upon difficult problems, without sometimes coming near truths reserved for later thinkers to see more clearly and unfold. In mechanical invention how many thousands get a vague notion of what ought to be done, but fail to discover how to do it. It is the same in speculative science, and he only ought to be held as a discoverer who leaves his work definite, intelligible, and complete. If Sweden had offered more scope for the engineering and metallurgical talents of Swedenborg, his career might have been materially changed, and instead of being the mystical prophet of a small though important sect, his visions might have wandered less

freely through imagined realms of spirits, and have been chiefly confined to regions in which his statements could be tested, and his alleged facts subjected to proof.

From his father, Swedenborg inherited what he took for the faculty of spirit intercourse. "From his childhood, when on his knees at prayer, his breath was curiously holden within him; strange rays of light, from the sun of another country, from time to time had broken in through his darkness." These words are his biographer's, but he tells in his own, how flames of various colours appeared to him while he was writing one of his books, as evidences of the truth he was recording; and "this was before the spirits began to speak with him as man with man." The development of the visionary faculty took place at a comparatively late period of his life, and is placed by Mr. White as lasting from his fifty-fifth year to his death at eighty-five.

In 1858 a small volume was offered for sale to the Royal Library at Stockholm. It proved to be a diary kept by Swedenborg between 1743 and 1744, and the extracts cited by Mr. White show that he passed through well-known stages of religious madness. A sense of desolation was experienced, though in a mild form; but soon, he says, "all was heavenly, clear at the time, but inexplicable now. In one word I was in heaven and heard speech, that no tongue can utter, nor the glory and the innermost delight which followed this speech." He next believed that Jesus Christ appeared to him in person, and in the whole of his subsequent life he believed himself to be a divinely chosen instrument for conveying religious truth to man. As a curious instance of his mode of interpreting his visions, we find this entry.

"Dr. Morsus appeared to be courting a handsome girl, and she allowed him to do with her what he liked. I joked with her because of her easy consent. She was a handsome girl, and grew taller and prettier. This means that I should obtain information and meditate about the muscles."

In London he appears to have gone quite out of his mind, stripping himself naked, and rolling in a deep, muddy gutter, but he did not remain in this condition, and was soon able to take care of himself, and act rationally until his death, though seeing visions, and receiving spiritual visitants nearly the whole time. Returning home he resumed his official duties, and employed his leisure in learning Hebrew; but believing himself to have a divine mission, he soon resigned his assessorship, and devoted the rest of his life to theological pursuits.

The theological career of Swedenborg could only be fairly traced in connection with the history of religious thought.

His followers consider that the reality of his alleged visits to heaven and hell, and the truth of his opinions are shown by the force of internal evidence. No one doubts Swedenborg's veracity or honesty, and those whose minds impel them to accept his system as a matter of faith, find no difficulty in believing that he was favoured above other mortals with a spiritual insight. Others, while admitting that his multitudinous writings contain many beautiful and true ideas, see no reason for entirely separating his case from thousands of others, in which cerebral disorder has existed, and given rise to analogous hallucinations. We do not intend to discuss or describe his theological views. They are tolerably well-known, and his followers circulate them abundantly in tracts and publications easily obtained. One very fine thought occurs in his delineation of the spirit worlds, which he conceives to be untrammelled by limitations of space. Nearness of mind and heart, according to his philosophy, cause spirits to appear in each others presence, and no physical journeying is necessary to bring together those whom active love and sympathy unite. As a rule his statements concerning heaven and hell are nothing more than ingenious applications of the notion that terrestrial existence is the type of all existence. Joys and pains, temptations, clothes, houses, etc., etc., are, according to his descriptions, much the same in the spirit worlds as on earth, and it is difficult to understand how any one can see in such delineations proof of anything more than an ingenious constructive faculty, acting more or less under the stimulus of cerebral disease.

Great stress has been laid by some on Swedenborg's apparent knowledge of events not within the reach of ordinary faculties to discover. For example, at Guttenburg he is reported to have described a fire then raging at Stockholm, 300 miles distant, and after appearing to watch the progress of the flames, he exclaimed, "Thank God, the fire is extinguished the third door from my house;" which proved to be correct. A few other stories of an analogous nature are handed down with evidence of authenticity more or less complete. Such narratives are, no doubt, puzzling. They belong to a very numerous class; and in all ages visions, dreams, and presentiments have occasionally proved true. To affirm that such cases cannot possibly be more than chance coincidences would be to assume a knowledge we do not possess, while to maintain that they are proofs of supernatural agency is to invent an explanation not warranted by the evidence.

Those who wish to know more of Swedenborg will do well to consult Mr. White's volumes, which contain much curious matter, and furnish specimens of his writings on various subjects.

We should have recommended Mr. White to have employed a more dignified tone in some of his controversial remarks; but he has, on the whole, produced a work that exhibits unmistakeable marks of industry and research, and will enable Swedenborg to be better understood by general readers than heretofore.

ARCHÆOLOGIA.

At a recent meeting of the British Archæological Association, on April 10, a number of FORGED ANTIQUITIES were exhibited, differing in many respects from the forgeries in lead and cock-metal from the manufactory in Rosemary Lane, to which we have now been so long accustomed. This new class of forgeries seems to have made its appearance about the month of November last, and the articles are usually represented as having been found at Brooks's Wharf, Queenhithe. The objects produced on this occasion were all made of zinc, and had been washed or dirtied so as to give them an appearance of age. The first was a small kneeling figure holding an open book, evidently copied from some one of the plaster casts commonly hawked about the streets, but with the addition of a nimbus. Another was a small vase, or ampulla, bearing a figure of St. Barbara; and this same figure is repeated on a brooch pretended to have been discovered in January last. There was also a pin in the shape of a sword, four inches long; a gauntleted hand and arm, as if broken off from a statuette; a small label inscribed "Amurs," intended to appear as if it had formed the foot-rest of a small effigy; another small ampulla; two horn-shaped vessels about four inches long; a brooch in form of a helmet; another gauntleted arm; a small gauntlet, and a right leg incased in armour, having the look of a part of the Manx arms. Several of these articles are furnished with rings, to give them the appearance of having been worn as personal ornaments. A very prevailing form of ornament upon them consists of pellets arranged in rows, circles, and other devices.

Mr. Ecroyd Smith has sent us a copy of his *Notabilia of the Archæology of the Mersey District*, in which he gives a much more complete account of the ANTIQUITIES found of late years on this part OF THE CHESHIRE COAST than in the report published in the *Reliquary* from which we gave some notes in our last. We were ourselves led into error, it appears, in an important circumstance in regard to these antiquities. They are not, Mr. Smith informs us, "washed up" on the beach. "They are washed *out*, and often *down*, but never *up*. Thousands lie in all probability buried under the Great Hoyle Bank far extending to the eastward, and over the site of the early settlement or village." It appears that there was here anciently a promontory, on which the Romans formed a settlement, and which was subsequently occupied by Saxons and Normans; it was known in the middle ages by the name of the Meols; but

the sea has for centuries been gradually gaining upon it, until now nearly all that remains above water consists of a sand-bank at some distance from the shore. In his pamphlet, which is a reprint from the *Transactions of the Historic Society of Lancashire and Cheshire*, Mr. Ecroyd Smith has given interesting sections of the present coast, showing the different strata of deposit, which represent different periods, Roman, Saxon, and Mediæval, with an indication of the class of objects found in each. Perhaps one of the most interesting discoveries recorded here by Mr. Smith, is that of a number of leaden pans, undoubtedly of the Roman period, found at a depth of ten feet near the bank of the river Weaver, at Northwich in Cheshire, and first announced to the public by Dr. Kendrick, of Warrington. They were no doubt used by the Romans for boiling the water to extract salt; in fact, Roman brine-pans. Northwich, like most of the places with names in which this syllable *wich* enters, such as Nantwich and Droitwich, are nearly always sites occupied by the Romans for salt-making, and Dr. Kendrick suggests that this may have been the Roman *Salinæ*, which others have placed at Droitwich; but there may have been several places to which the Romans gave this same name. These brine-pans furnish an interesting illustration of the manner in which the Romans in this island manufactured their salt. It is a curious fact that in early mediæval charters connected with Droitwich, the brine-pans are termed *plumberia*, indicating that they were made of lead, and a certain number of them are stated to have constituted a *bullerium*, or boiling. All these discoveries are of very great importance to the physical and moral history of the district, and too much praise cannot be given to Mr. Ecroyd Smith for the zealous care with which he has collected and recorded the facts.

We are glad to be able to announce that the town of Liverpool has decided on rendering an honourable act of justice to the name of one of its most eminent and distinguished townsmen, to whom, among many other benefits, it owes the gift of a noble museum of antiquities (which has just been removed into the building newly destined for its reception), by erecting a STATUE TO JOSEPH MAYER. It is to be executed by Signor Fontana, who is now, we believe, at Liverpool, engaged upon it, and to be placed in St. George's Hall.

A remarkably interesting discovery of ROMAN SEPULCHRAL REMAINS has recently been made in a field between Silsby and Barrow-on-Soar, in the county of Leicester, about three miles westward of the fosse-way running from *Ratæ* (Leicester) to *Lindum* (Lincoln), and six miles north of the former town. The accidental excavations to which we owe this discovery appear to have extended over part of a regular Roman cemetery, which contained above a dozen separate interments, and furnished a certain number of objects, which have been presented to the Leicester Town Museum. We have before us a beautiful photograph and a lithograph of the greater part of these objects, and a plan of the site of the excavations, with the places marked on which each object was found. Among the latter were no less than five large wide-mouth glass vessels, which contained burnt human bones, each taken from a separate interment. Four of them were rectangular, or four-

sided, and the fifth was six-sided, and one had two handles. One was found inclosed in a chest of limestone. Only one clay cinerary urn was met with; but in one grave was found a large, almost globular, amphora, two feet six inches in height, and two feet in diameter, computed to hold fifteen gallons, which had perhaps been used as a sepulchral urn, for it was found in a fragmentary state. It should be added that the mouths of two of the glass vessels were almost hermetically sealed with lead. Near the limestone cist containing one of the glass vessels were found together two iron lamp-stands, with the iron moveable rods attached, by which they might be suspended to a wall. They had perhaps been used to support lighted lamps in a small sepulchral chamber or cist, and lamps have been found not unfrequently under similar circumstances in Roman interments in our island. Among other fragments was a piece of a vessel made of the red glazed pottery, which our antiquarians seem now agreed in calling Samian ware. Besides these interments of burnt bones, there were found five skeletons, the remains of bodies which had been buried entire. It is evident from many similar discoveries, that the two practices of cremation and burial of the body entire prevailed in Britain during the whole Roman period, and that the adoption of one or the other was a mere question of individual choice. After the second century, the practice of burning the dead began rapidly to be discontinued in the south, until it disappeared entirely under the Christian emperors. But it is probable that the influence of the imperial laws and regulations in such matters as this extended but slowly into the distant provinces; in the more fashionable parts of Roman Britain we find both modes of interment intermixed in the same cemetery, while, as we approach what must have been the remote districts, the burial of the body entire occurs less frequently. In the cemeteries at Wroxeter, the Roman *Uriconium*, a very large town, which was not destroyed till the very close of the Roman period, down to the present time no single instance has been found of burial otherwise than by cremation. The ashes of the dead were usually deposited in an earthenware vessel, generally of a form which was no doubt made for this peculiar purpose. Sometimes, when they were perhaps made in a hurry, for the necessity of the moment, in localities where they were not always to be had ready made, they are of very rude and imperfect work. The glass vessels used for this purpose are less common, and, as they are usually of very good material and workmanship, they were, probably, only used by people of a superior class. We may suppose that this cemetery at Barton-on-Soar belonged to people of a superior position in society, who not only used glass vessels for interment when they still practised cremation, but who had adopted to a considerable extent the more fashionable mode of burying the body entire. The urn itself, whether of earthenware or glass, was sometimes buried, as here, in a cist or coffin; and sometimes, as we have found in many instances in Britain, it was placed within an amphora, the upper part of which had been skilfully broken off to allow of the urn being put inside. We are informed that the amphora found at Barton-on-Soar had been filled with charred wood, among the remains of which were found large nails;

these globular-shaped capacious amphoræ are not common. An instance of one used, probably like this, for inclosing the ashes of the dead, was found at Colchester some years ago. In a grave in the Roman cemetery at Cirencester (*Corinium*) an urn receptacle was found, which appeared to have been one of the stones of a cylindrical column, sawn in two, a hole made in the centre to receive the urn, and then the two parts united again. In the middle of this cemetery opened at Barton-on-Soar was found a square area covered by a rubble floor, which no doubt served some important purpose connected with the burial place.

While speaking of Roman interments, we may state that two ROMAN LEADEN COFFINS have recently been discovered near Milton-next-Sittingbourne in Kent, one containing the skeleton of a female, the other that of an old man. It is said that, when first opened, a white beard, descending to the breast of the latter, was distinctly visible. One earthern and two glass vessels were found accompanying it. These leaden coffins of the Roman period are found rather frequently in Britain. Perhaps they belong to a rather late date, as, in at least one instance, an interment in a leaden coffin, evidently in the Roman manner, has been found in an Anglo-Saxon cemetery, as though the practice had continued after the close of the Roman period.

T. W.

PROGRESS OF INVENTION.

NEW SOURCE OF THE TANNING PRINCIPLE.—Notwithstanding all our improvements in arts and manufactures, it may still be said, with truth, that "there is nothing like leather." This valuable substance has often been imitated, but it has never been superseded, and probably never will. To facilitate and cheapen its manufacture is, by consequence, a matter of considerable importance. The tanning principle obtained from vegetables is more or less limited in supply, and therefore costly; and a natural attempt to economize it results but too often in the production of an inferior leather. Artificial tanning has been proposed, but as it has hitherto been best obtained from resin, it also is expensive. Recent experiments have shown that it may be formed with great facility, and at a trifling cost, from bituminous coal or lignite; the latter answering best on account of its permeability by liquids, a property of some importance from the nature of the process employed. This consists merely in heating the coal or lignite for a considerable time with nitric acid, and then evaporating to dryness. The residuum, a dark brown substance, is entirely soluble in alcohol, ether, concentrated sulphuric acid, the alkalies, and their carbonates; but it consists of two portions, one of which only is soluble in water, the solution having an acrid and bitter taste, and being capable of precipitating albumen and gelatine. Should it be found an efficient substitute for the tanning principle of vegetables, which is not unlikely to be the case, the cheapness and abundance of the source whence it may be obtained will considerably affect the economic production of leather.

PECULIAR APPLICATION OF ELECTRICITY.—The brilliancy of the electric spark very soon suggested it as a means for obtaining artificial light, and numerous experiments were made with the object of utilizing it in that way. These experiments, though not altogether unsuccessful, led to no practical results. Among the difficulties experienced in the application of machine electricity to the purposes of illumination, one of the most serious was the impossibility of obtaining perfect insulation. This does not exist to the same extent with galvanic electricity, and hence the application of this form of electricity to illuminating purposes has been attended with better success; and the improved modes of producing it, and other forms of that agent having a controllable intensity, has given an impetus to the efforts of those who count on the application of the electric light to practical purposes. One of the most curious instances of this application is, perhaps, that recently made in Paris for the production of theatrical effect. Light metallic crowns, having slight interruptions, were worn by some of the performers; and when the galvanic current from a concealed battery was transmitted through these crowns, brilliant stars of light were produced at the interruptions. The most costly diamonds would not have afforded an equally brilliant effect. The danger of so powerful an agent as a strong galvanic current in the hands of the inexperienced or the neglectful, was illustrated, at the same time, by the fact that one of the performers was seriously injured, the head having been allowed to form a part of the circuit.

SONOROUS VIBRATIONS, A MEANS OF MEASURING MINUTE PORTIONS OF TIME.—An apparatus recently perfected by M. Niaudet-Breguet affords a simple means of measuring, with ease, extremely minute portions of time. In its earlier forms, this apparatus was employed only to record graphically the vibrations of sonorous bodies. It originally consisted of a tuning fork, on one branch of which was fixed a point, that, when the fork was set in vibration, described a sinuous line on a cylinder covered with lamp black, and made to revolve by clock work. To render the vibrations continuous, instead of lasting but a very short time, each branch of the tuning fork was alternately attracted by an electro-magnet, which was placed very near it, and which was, at suitable intervals, placed in connection with a galvanic battery, by means of the apparatus usually employed for making and breaking connection with the ordinary induction coil. The apparatus was so arranged that the sound produced by the apparatus for making and breaking contact was in unison with, or some octave of that of the tuning fork; which was effected by turning the regulating screw.

The next improvement introduced into the apparatus, was the substitution of one of the branches of a tuning fork, having a pitch corresponding to the tuning fork attached to the apparatus for graphic delineations, instead of the vibrating metallic slip, used with the induction coil.

M. Niaudet-Breguet's improvement consists in the use of an horological instrument, in which the pendulum is replaced by a tuning fork; the movement of the wheel work being controlled by

the vibrations of the fork, and the vibrations of the fork being rendered continuous, by means of the impulses derived from the wheel work. Hands and a dial indicate the velocity of vibrations. The tuning fork constituting the pendulum being connected with that of the apparatus for graphic delineations, and made to correspond with it, as to pitch, the dial will tell the number of vibrations made by the tuning fork of the recording apparatus. Tuning forks of various pitch may be used with the horological apparatus, since their rates of vibrations are not affected by the intensity of the moving power. Or one tuning fork may be regulated to different pitches, by symmetrical and equal weights, which are made to slide along the branches. For small changes, screws fixed in the branches, and moving in and out parallel to the axis of the fork will afford a sufficient power of regulation.

This instrument enables us to measure very minute intervals of time, to regulate the velocity of the movements communicated to astronomical instruments, and to obtain synchronism between two apparatus, at considerable distances apart, and notwithstanding great variations in the intensity of the motive power, a matter of great importance in telegraphy.

Application on Sulphuret of Carbon to the Preparation of Perfumes.—The ordinary tedious, and wasteful mode of obtaining odoriferous principles from flowers, is likely to be superseded by one far more simple. It consists in an application of the affinity which the sulphuret of carbon has for these principles. A flask containing the petals of flowers recently gathered, having been filled up with the sulphuret is corked and shaken. It is then left at rest for about six hours, after which, the sulphuret being decanted into a flask containing the petals of similar flowers, it is corked, agitated, and left to rest as before. The same thing is done with a third and a fourth flask of petals. The sulphuret will then be found deeply coloured, and floating on the water which it has driven out from the pores of the flowers. Having been separated from the water, if the quantity is small, it may be evaporated by mere exposure to the air, and the residue treated with alcohol. Or it may be mixed with oil of sweet almonds, then shaken several times a day for three or four days, and afterwards placed in an open vessel and exposed to the air. If the mixture of sulphuret and oil of sweet almonds is considerable in quantity, it should be distilled at the lowest sufficient temperature, in a water bath. Were the temperature allowed to become too high, some of the sulphuret of carbon would be lost, and some of the aromatic matter destroyed. Equal parts by weights of petals and sulphuret, and a little more than one-third of the weight obtained of the petals oil, are very suitable proportions. The perfumed oil in this way answers well for every purpose requiring the use of aromatic essences.

Simple Mode of Gilding Porcelain.—A bright coating of gold, without the use of the burnisher, may be produced on porcelain by very simple means. For this purpose two compounds are first to be prepared. The first is formed by dissolving thirty-two parts gold in aqua regia formed with equal quantities nitric and hydrochloric acid,

and then adding to the solution one-fifth part tin and one-fifth part butter of antimony, and, after the application of heat, diluting with five hundred parts water. The second compound is formed, by gently heating sixteen parts sulphuric acid, sixteen parts Venice turpentine, and thinning the uniform dark brown mass thus obtained with fifty parts oil of lavender. The two compounds are to be mixed and well stirred, heat being applied, until a uniform liquid is obtained. The water and excess of acid separates, on cooling, from the resinous mass, which having been well washed with water, and then freed from moisture, is to be thinned by the addition of sixty-five parts oil of lavender, and one hundred parts oil of turpentine, the perfect incorporation of the constituents being hastened by heat. Five parts basic nitrate of bismuth are now to be added to the resulting uniform mass, and after the mixture has been allowed to rest, the clear portion is to be poured off. This is the material used for gilding. It is applied to the porcelain in any convenient way, and dries very quickly. After the porcelain has been subjected to a high temperature the gilded portions are very brilliant.

New Textile Fibres.—There are many plants found in great abundance, that would furnish large quantities of excellent textile fibres, were it not found extremely difficult to separate them from the woody portions. It has been found that this difficulty may be overcome by very simple means. The stalks are first to be passed between rollers for the purpose of disaggregating them. Having then been placed in a vessel containing a very weak solution of commercial soda, steam, having a pressure of four or five atmospheres, is to be passed into the solution, which is to be kept at a boiling temperature for a time, which varies with the nature of the plant. The yellow brown cellulose thus obtained, is to be washed with water, to which a small quantity of hydrochloric or sulphuric acid has been added, to neutralize any alkali that may be present, and is then to be placed in any bleaching fluid. When removed from this, to prevent colorization being again produced, it is to be washed in any extremely dilute solution of carbonate of soda, and is then to be left in a weak solution of chloride of lime. The brown colour first produced by this latter treatment, is succeeded by a brilliant and permanent whiteness.

Panoramic Photographs.—Very simple means have been recently devised for producing panoramic views of almost any extent with the ordinary camera, and the results thus obtained are such as leave nothing to be desired. For this purpose the camera is made to revolve on a centre, the positions to be given to it in succession being indicated by a graduation on the plate upon which it rests; and the glass plate is made to slide in a groove, so that different portions of it may come successively into the required position behind the objective, the proper changes of position being indicated by notches. Such an arrangement will, it is evident, in theory, secure the desired effect; but in practice it is, as might be expected, found, from the impossibility of making the boundary of one part of the view exactly to correspond with that of the succeed-

ing, that the union of both is indicated by a line, a circumstance quite sufficient, if irremediable, to render the contrivance inadmissible. This difficulty is, however, easily obviated by the use of a suitable diaphragm placed within the camera at a proper distance from the objective and the glass plate. There is thus produced a kind of penumbra in one position, which is rendered perfect by exposure during the next position. The impressions corresponding to the successive portions of the view being in this way made to blend with each other, so that no line of demarcation between them can be perceived. Five or six movements of the camera and the plate are found quite sufficient for a very extended view.

Application of Air charged with Combustible Vapours.—Inflammable gases are frequently rendered capable of imparting a more brilliant light, during combustion, by charging them with hydrocarbon vapours. Experiments are, however, being made at present in Russia with atmospheric air charged with these vapours, and the result is said to be the production of a combustible gas capable of affording a heat sufficiently intense to melt steel. Atmospheric air is forced through oil of turpentine, and carries along with it an amount of the fluid sufficient to cause, during its combustion, not only the evolution of an intense heat, but the emission of a clear and brilliant light. It is intended, in this way, to provide fuel for some small steamboats which are intended to run on the Neva. Such an arrangement may be found convenient, and even economical, in certain circumstances; but if it is used, it will be necessary to guard against the danger of explosion. This, however, may be done by very simple means.

Miscellaneous.—*New Application of Photography.*—Photography now enables us to obtain the picture of a projectile passing out of the mouth of a gun. For this purpose it is necessary to have a collodion which requires a very short exposure, and a means of rendering the exposure and the ignition of the charge perfectly simultaneous. The latter, which would be impossible to any degree of manual dexterity, is effected by very simple and infallible means. The current of galvanic electricity which by rendering a thin platina wire incandescent, explodes the charge, excites an electro-magnet that raises a disc from the front of the lens of the camera. When the wire has melted, that is, when the ignition of the charge is complete, the disc falls in front of the lens.——*Reinforcement of Photographic Negatives.*—A negative may be imperfect from insufficient exposure, in which case the details will not be well brought out: or from the collodion, the silver bath, or the developer being out of order, in which cases it will not be sufficiently opaque. The former imperfection may be removed by means of pyrogalic acid, to which has been added citric acid and a few drops of aqueous solution of nitrate of silver. The latter, by means of, first, an aqueous solution, containing three per cent. of chloride of copper, then washing with water, applying an aqueous concentrated acid solution of sesquichloride of iron; again washing, then applying an aqueous solution of iodide of potassium, which has been saturated with pure iodide of silver, and finally washing. If

both defects are present at once, the two remedies must be employed in succession.——*Estimation of Silex in Wheat.*—It has long been known that silex is a necessary constituent of the wheat stalk, a deficiency of it leading to a tendency in the wheat to be easily overthrown by wind or rain; hence the application of siliceous manures. On the other hand, it has been found that wheat-straw containing even more than the normal amount of silex is liable to the danger of being prostrated. M. Isidore Pierre has enabled us to reconcile these apparent contradictions. The silex is found in very different quantities in the leaves, the knots, and the spaces between the knots —the leaves containing, for a given weight, far the largest quantity. The more luxuriant the leaves, therefore, the greater the amount of silex, but the greater also the weight to be borne by the stalk; and the less capable it is of bearing it, being hindered from becoming dry on account of the free access of air being prevented. The errors on this subject have, therefore, arisen from estimating the silex as a whole, and not considering by itself the portion found in the stalk. Not that the entire of what is found in the leaves is ineffective: for a part of the leaf is in the form of a sheath, which adds to the strength of the stem. But this sheath is not proportionately increased when the leaf becomes very luxuriant. Weight, therefore, but not at the same time strength, is added, when the leaves are greatly developed. Hence the advantage sometimes found in thinning the leaves before the ear begins to form.——*Waterproof Cement.*—It has been found that the addition of coal-dust to ordinary cement renders it completely water-proof, and imparts to it great solidity. For this purpose two parts of fine cement, one part coal-dust finely pulverized, and one and a half parts slaked lime, may be used, the whole being brought to a proper consistency by the required amount of water.——*Sensitive Litmus Paper.*—We have given an extremely sensitive test for acids; but as litmus paper is, in ordinary circumstances, very convenient, it is desirable, if possible, so to prepare it as that it may be relied upon. This is easily done. It is highly sensitive only when its colouring matter consists of the red principle of the litmus, combined with subcarbonate of potash. Any substance having a greater affinity for the red principle than the potash will decompose it. Commercial litmus paper often contains the red principle, united with subcarbonate of lime, instead of subcarbonate of potash, a compound decomposed with considerable difficulty. To prevent the presence of the calcium compound, the paper should, before the application of the colouring matter, be immersed in a weak solution of hydrochloric acid, which removes the lime, and thus secures the production of a test paper containing only the highly sensitive compound.

PROCEEDINGS OF LEARNED SOCIETIES.

SOIREE OF THE ROYAL MICROSCOPIC SOCIETY.

The annual *soirée* of the Royal Microscopical Society was held at King's College on the 24th April; James Glaisher, Esq., F.R.S., the President of the Society, receiving the company, which was unusually numerous, and of a distinguished character. The supply of microscopes was very large, and the objects of greater variety and interest than usual. Mr. Sorby exhibited his excellent plan for comparing the spectrum of any object under the microscope with a standard absorption spectrum, obtained by transmitting light through quartz of a given thickness. Mr. Browning showed the same apparatus, carried out as devised by Mr. Sorby. Mr. Sorby likewise exhibited his dichroiscope, a new instrument for the examination of crystals, to which we shall revert on another occasion. Mr. Ross and Mr. Baker exhibited Mr. Slack's adjustible diaphragm for eye-pieces. Messrs. Powell and Lealand showed their binocular arrangement for high powers. Mr. Baker showed a variety of new apparatus, including his travelling microscope. Mr. Highley showed waistcoat-pocket and other portable microscopes, a new hydrocarbon demonstrating lantern, for exhibiting objects on a screen, etc. Messrs. Murray and Heath brought a new pocket microscope, and other useful novelties. Prof. Smith's mechanical finger was shown by Mr. Bailey, and by Mr. Browning in a simplified and economical form. Among the most important objects were a beautiful series, shown by Dr. Carpenter, illustrating the development of the comatula, from its pentacrinoid larva; Mr. Whitney's preparations, showing the development of the breathing apparatus of the tadpole; the structure of the hyalonema, and its encrusting polyps, by Mr. C. Tyler; some new and rare forms of rhizopoda, etc., obtained by Major Owen, by surface-skimming of the mid ocean; a diamond, containing an appearance of organic structure, by Mr. W. H. B. Hunt, etc., etc. Mr. Norman brought a very fine series of objects, and the tables of Ross, Powell, R. and J. Beck, Baker, Pillischer, How, Crouch, Collins, etc., were very attractive. In the course of the evening, Mr. Highley exhibited, with the oxyhydrogen lantern, some beautiful views of scenes in Australia and Africa, lent by Mr. Baines. The picture of the Victoria Falls of the Zambesi was much admired, and a view of that remarkable plant, the *Welwitchia mirabilis*, attracted great attention. In a living state the leaves are of a beautiful green, and like enormous ribbons stretching along the ground, while the flowers are fine red. Altogether, this *soirée* was the most successful that the Society has given.

LITERARY NOTICES.

HANDBOOK OF ASTRONOMY, by DIONYSIUS LARDNER, D.C.L., formerly Professor of Natural Philosophy and Astronomy in University College, London. Third Edition. Revised and Edited by EDWARD DUNKIN, F.R.A.S., Superintendent of the Altazimuth Department, Royal Observatory, Greenwich, with illustrations on stone and wood. (J. Walton.)—The plan of this work is to give first brief descriptions of methods and instruments, then to describe the earth, the moon, the tides and trade-winds; then to pass to the sun, the planets, comets, and fixed stars. Thus a large range of subjects is included in a comparatively small well-printed work, which contains the kind of matter required by general students. The illustrations are very numerous, and generally good; but those of nebula and clusters cannot be commended, and must be taken with large grains of allowance; that, for example, of the Great Orion nebulæ would scarcely be recognized by any one acquainted with its telescopic appearance. The chapter on the sun required more revision than it has been subjected to, and it is somewhat absurd on turning to "Stellar Clusters and Nebulæ," to find the latter spoken of as all resolvable if sufficient telescopic power were employed. Some defects of this description are corrected in an appendix; and, on the whole, the new edition may take its place among the useful manuals of the day.

THE ELECTRIC TELEGRAPH, by Dr. LARDNER. A new Edition, Revised and Re-written by EDWARD B. BRIGHT, F.R.A.S., Secretary of the British and Irish Magnetic Telegraph Company. With 140 illustrations. (James Walton.)—An interesting volume well brought down to date by its editor, and containing in a small compass a large quantity of important matter. We should have recommended the disuse of such a phrase as "the electric fluid is deposited in a latent state in an unlimited quantity in the earth," etc. Electric science certainly knows nothing of deposits of electric fluid, though the phrase may be excusable in newspaper paragraphs; and the deposition of fluid in latent state sounds absurd, unless it were a slang periphrasis for hiding a barrel of beer. There are many other passages to which objections might be taken, but, on the whole, it is a good popular work.

A DICTIONARY OF SCIENCE, LITERATURE, AND ART, comprising the Definitions and Derivations of the Scientific Terms in General Use, together with the History and Description of the Scientific Principles of nearly every branch of Human Knowledge. Fourth Edition, Reconstructed and Extended by the late Dr. T. BRANDE, D.C.L., F.R.S.L. and E., of Her Majesty's Mint; and the Rev. GEORGE WILLIAM COX, M.A., late Scholar of Trinity College, Oxford, assisted by Contributors of Scientific and Literary acquirements. (Longmans, Part xii. April, 1867.)—This number is a very thick one, commencing with Sigurdh, and ending with Zymotic, thus closing the work. We have very often expressed our opinion of this work. On the whole it is well done, and calculated to serve the ordinary requirements of educated families. The subjects of the articles are

well selected, and they are for the most part well written. The weak part is the natural history and microscopy. Physics, chemistry, astronomy, music, and a host of other subjects, are judiciously treated, and the general promise of the prospectus fairly carried out.

LIGHT; ITS INFLUENCE ON LIFE AND HEALTH, by FORBES WINSLOW, M.D., D.C.L. Oxon. (Hon.), etc., etc. (Longmans).—Dr. Winslow's work is popular rather than scientific. It is pleasantly written, and well adapted for family reading. The chapters on the supposed influence of the moon on disease, and especially on insanity, contain much important evidence in favour of ascribing such action to our satellite, but such a subject requires much more elaborate and scientific treatment than Dr. Winslow has given to it. With the very common tendency of diseases to periodicity, it would be expected that in a great number of instances their times of diminution or increase would coincide accidentally with the periods of any regularly recurring series of events. For example, the tides ebb and flow at fixed intervals, and it is a very common popular belief that the ebbing of the tides influences the termination of human life, and creates a period of maximum death. Now in a populous country nothing could be easier than to obtain an immense number of instances in which death paid its visits as the waters flowed away; but a more complete analysis would dispose of the theory by exhibiting numerous instances of its failure. In like manner, a doctor having a lunar theory will readily find apparent confirmation, but another doctor not possessed with such a theory would discover abundance of facts that did not coincide with it. The influence of the moon on the weather has been a prevailing belief in all centuries and ages, and yet how very few propositions affirming such action can be considered as at all substantiated. The moon may influence weather and may influence disease in more ways than one, but its influence may be so mixed up with other influences as to be difficult to disentangle, and by no means sure to dominate. It is rather surprising to find a physician of Dr. Forbes Winslow's standing citing with approbation the nonsensical remark of Mr. Steinmetz that sunshine consists of a *metallic shower* because the solar photosphere appears to contain incandescent metallic vapours. The ascription of physiological effects to the "iron vapour" of a sunbeam is more comical than scientific. In the first place there is not a particle of evidence that the sun sends us through his beams a supply of iron from his own body, and in the next place if a sunbeam were imagined to contain iron at all, the quantity would put to shame the infinitesimal doses of the homœopathists, at which Dr. Winslow would, no doubt, laugh. Sunbeams are *practically* imponderable in the finest balances, though if we conceive them as a motion of particles, the particles *may* have weight, though to an inappreciable extent. A great mass of concentrated sunbeams weigh *nothing*, or nothing appreciable, and yet they may contain iron enough for a medical dose! We hope Dr. Winslow will never overdose a patient after such a theory of infinitesimal action.

THE NORTH-WEST PENINSULA OF ICELAND; being the Journal of a

Tour in Iceland in the Spring and Summer of 1862. By C. W. Shepherd, M.A., F.Z.S. (Longmans.)—An elegant little book, with two coloured plates of Icelandic scenery, and containing a readable narrative of exploration into parts of the island which have escaped previous tourists. The picture of the hardships to be endured by travellers among the hospitable, but poorly provided Icelanders, is not very inviting, and agrees substantially with the experience of other travellers. Scattered through the work are many interesting illustrations of the physical geography of the island, and of the effects of its severe winters. Of a valley near the Dranga Jökull, the writer remarks, "No place could show the awful effects of the breaking-up of an Icelandic winter more than the valley before us. It was itself a deep ditch with mountain walls. Through the centre ran several broad glacier streams, white and rapid, intersecting one another in every possible manner and direction. Huge snow-drifts also climbed the mountain sides, and large masses of rock and earth were strewn about, having descended from the heights above. One mass in particular drew our attention. We saw it long before we reached it, and thought it was a house in the distance. It had bounded into the centre of the valley, and was so strongly held together by the turf upon it, that it remained unbroken, and presented the shape of an arch with a span of ten feet, and would almost admit of my walking under it." The account of an eider duck island is likewise very interesting, and the book will well repay perusal.

NOTES AND MEMORANDA.

Devitrification of Glass.—M. Clemandot has a paper in *Comptes Rendus* in which he states that desiring to make a very simple and very dispersive crown glass, he used silica and soda exclusively, without any lime, and with great excess of the first material. While in complete fusion at a high temperature he withdrew a portion of the glass which remained unchanged for ten years, but the mass left in the crucible underwent devitrification as it cooled. He adds that glass is most solid and most unalterable when it contains the greatest number of bases in its composition, but that an excess of any material leads to devitrification.

Variation of Species.—M. C. Dareste brings before the French Academy an instance of the progeny of a hen near Lille resembling the so-called *Poules de Padoua*, as Polish fowls are improperly called. Two chickens, which died before they were hatched, exhibited the peculiar protrusion of the brain between the frontal bones, which characterises this breed, although no trace of its having been at any time crossed with the Lille fowls could be discovered. In another case a cow and calf assumed the characters of a bovine race of South America, the *nata*, or *nidta*, which had a peculiarly short dog-like head, and which seems to have completely disappeared. Several other cases are mentioned in the same paper.

Huggins on the Spectrum of Mars.—Mr. Huggins' paper in *Monthly Notices* shows that the C line in the solar spectrum exists also in the spectrum of Mars. A strong line distant from C, at about one fourth the distance from C to B, which does not exist in the solar spectrum, was satisfactorily determined. Faint lines were seen on 14th Feb., on both sides of D, similar to those which appear when the sun's light traverses the whole of the atmosphere, and which were in like manner to be produced by the atmosphere of Mars.

Mr. Browning's Sun Screen.—Mr. Browning has adopted a modification of Foucault's proposal to silver an object-glass by Liebig's process, and view the

sun through the transparent metallic film, which diminishes the light, and prevents the heat reaching the eye. He has used with success a carefully prepared flat disc of glass, silvered on one side, and placed at the mouth of his silvered mirror reflectors. With such an apparatus, applied to Mr. Barnes' 8½-inch telescope, he observed the eclipse of March 6, and saw the mountains on the dark margin of the moon beautifully projected on the luminous disc behind, the protuberances on the S.E. being most prominent. He also noticed that the minimum temperature was not attained in Mr. Barnes' garden (Camden Road, N.W.) till half an hour after the maximum of the eclipse.—*Monthly Notices.*

Brooke on Electric Energy.—An important paper by Mr. Charles Brooke, F.R.S., will be found in the *Proceedings of the Royal Society*, No. 91, the gist of which is that light, heat, electricity, etc., are modes of motion of the particles of matter, and not of an imponderable ether filling up the interstices of matter. He supposes that space is filled with a highly attenuated, but still ponderable substance (ether), which transmits light and heat which is not miscible with our atmosphere any more than oil is with water, but floats upon it. Copper will transmit electricity at the rate of 250,000 miles a second, and other appropriate kinds of matter may in like manner transmit light and heat.

Cassella's Embossing Self-Recording Anemometer.—One of these instruments has recently been erected at Kew Observatory. It has the hemispherical cups of Dr. Robinson, but the registering apparatus has been devised by Mr. Cassella and Mr. Beckley. A narrow slip of paper, sufficient to last a month or six weeks, is wrapped round a roller; this strip is unwound by a clock movement, which marks each hour by embossing an arrow upon it, and figures, expressing the wind's velocity in miles, are embossed on one edge. We are informed that the performance of this ingenious instrument works is highly satisfactory.

Slow Incubating Silk-Moth Eggs.—M. Guérin Méneville describes in *Comptes Rendus* a race of silkworms whose moths only produce one generation in two years, and the incubation lasts eighteen months. This variety was raised in South America from eggs sent from Europe, and their peculiar behaviour in this hemisphere was first noticed in Italy.

Prehistoric Art.—M. Peccadeau de L'Isle exhibited recently to the French Academy specimens of wrought flints, barbed arrows, etc., from Bruniquel, and among them a figure which he said might have been intended as a fantastic creation by its author, or possibly meant for an elephant, sculptured on a piece of reindeer horn.

The November Meteors.—Professor Adams has communicated to the Royal Astronomical Society the result of his investigation as to the true orbit of these bodies. Upon calculating the perturbations caused by the action of Venus, Jupiter, and the earth upon the node of the nearly circular orbit, having a period of about 11 days less than that of the earth, in which the meteors have been supposed to travel, he finds that the result is not sufficient to produce one-half of the observed motion. He was therefore driven to the alternative of adopting an elliptical orbit, with a period of 33¼ years, extending beyond Uranus, and he then found that perturbations caused by Jupiter, Saturn, and Uranus, the only planets now likely to affect the meteors, produced exactly the required amount of motion in the node. He proceeded to ascertain all the elements of the orbit, which were found to be almost identical with those of Tempel's comet, thus corroborating the speculation as to the identity of these bodies very remarkably.

The Vaginicola Valvata.—Mr. J. G. Tatem, of Reading, informs us that the valved vaginicola described by Mr. Slack in our last number is common in that neighbourhood.